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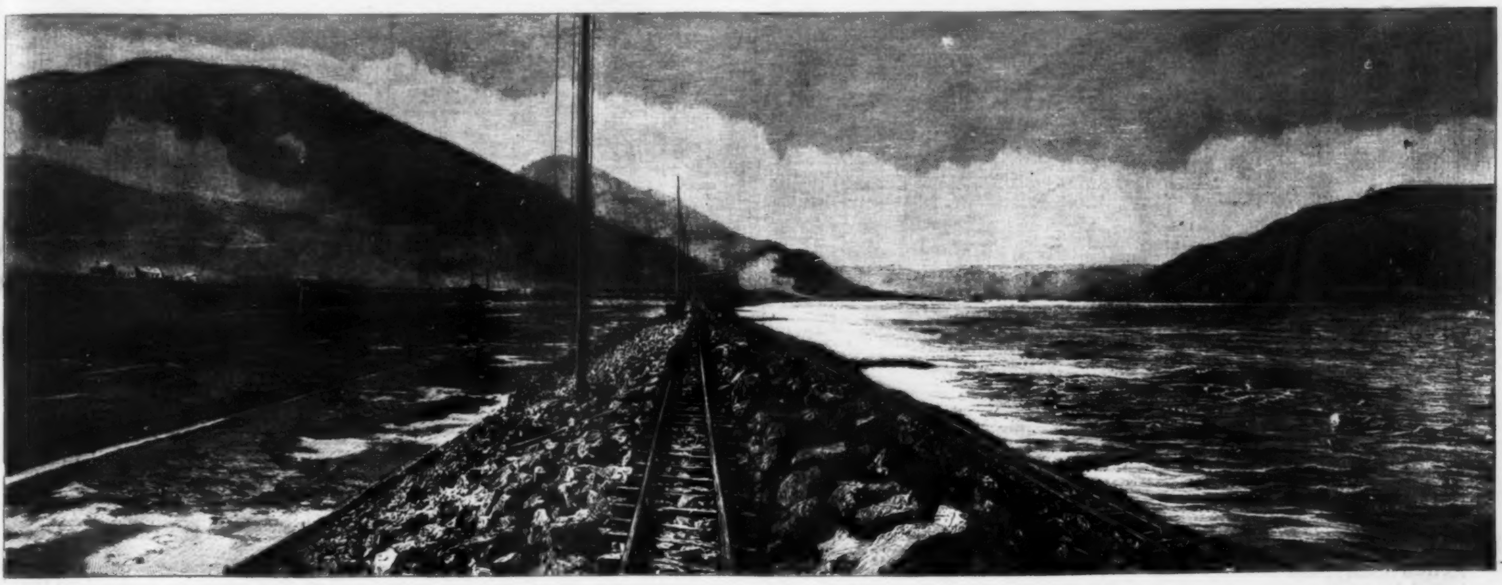
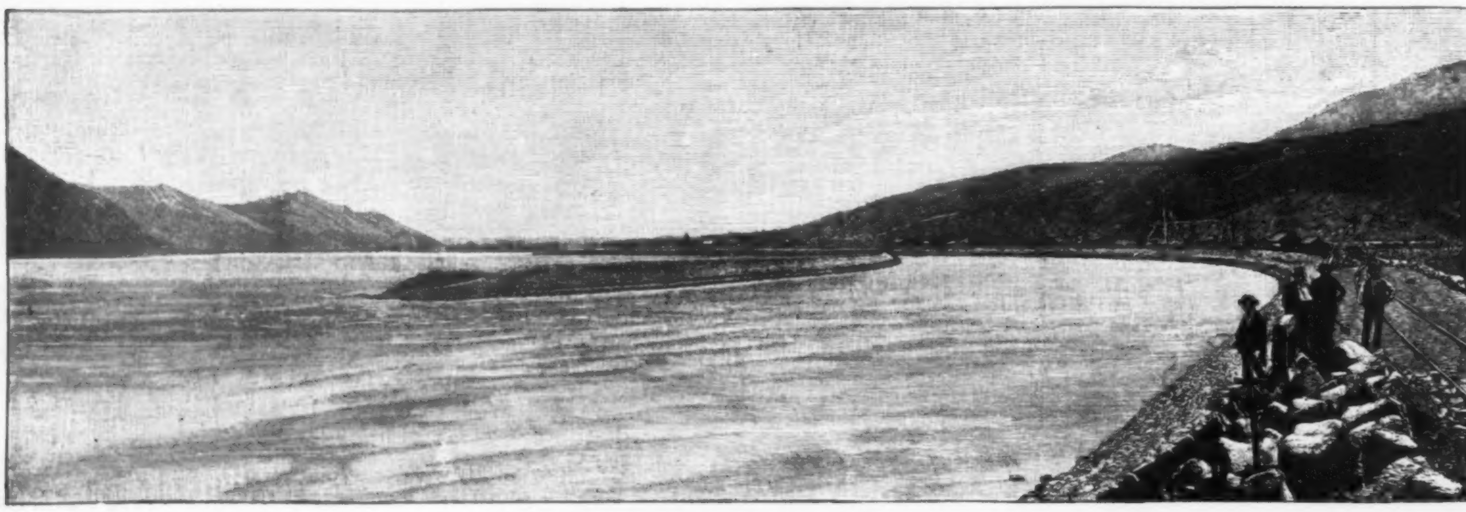


THE IRON GATE—AT THE LEFT, THE CANAL; IN THE CENTER, DAM IN COURSE OF CONSTRUCTION; AT THE RIGHT, THE DANUBE, WITH RAPIDS.

VIEW AT KASAN—AT THE LEFT BANK, ABOVE THE WATER, TRACES OF THE OLD ROMAN PATH.

OPENING OF THE DANUBE TO NAVIGATION.

As the year 1869 will always be a memorable one in the history of civilization on account of the opening of the Suez Canal and the benefits resulting therefrom to transoceanic commerce, so will the year 1896 be remembered as the one in which another great piece of engineering was accomplished; we refer to the removal of the cataracts in the lower Danube, or as it is generally spoken of, the blasting of the Iron Gate. In this, German enterprise and German capital have accomplished a work which will hold a prominent place in history, and which will enable the Danube to fulfill its great mission as a means of communication between Western Europe and the Orient. All of the Danube states had great reason for rejoicing on September 27 when this great watercourse was opened to the traffic of nations.



ENTRANCE TO CANAL.

The opening of the lower Danube for navigation has its own history, and it is no small one, for it can be traced through a period of almost eighteen hundred years. Remains can still be found of a path and a canal made by the Romans along the wild stream at the Iron Gate; this is attested by an inscription chiseled, apparently in the year 101 A. D., in the rocky wall opposite Ogradena, and which reads as follows:

"The great Cæsar, son of the deceased Nerva, Nerva Trajanus Augustus Germanicus, High Priest, possessing the power of Pontiff for the fourth time, father of his country, Consul for the third time, has had a road made here by cutting away the rock and putting in supporting beams."

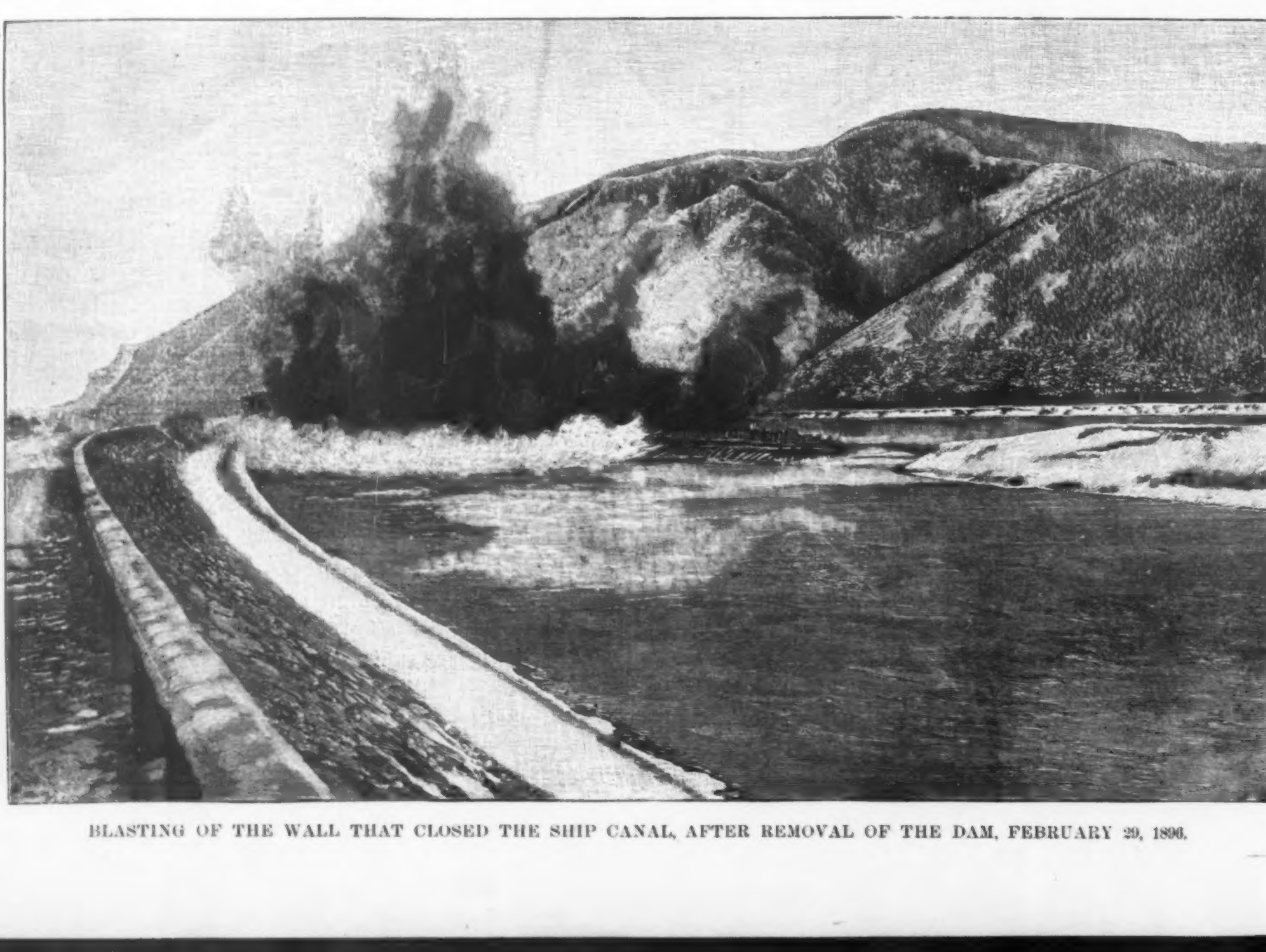
There is a similar tablet farther up the river near the cataracts of Kosla and Dojke, above Svinitza, which tells that the great Roman Emperor Trajan undertook the building of a path along the rocks that extended almost perpendicularly into the water, and which, like that referred to above, was probably constructed under the direction of the illustrious architect Apollodorus, probably the first constructor on the Danube. A portrait of him can still be seen in a good state of preservation on the Arch of Constantine in Rome.

The centuries of warfare that followed, the unsettled times when nations were migrating, the bloody wars between the Turks and the Hungarians for the possession of the river, and finally the recent unfortunate political conditions of the states on the Danube, prevented the execution of thorough improvements in the river, the dangers of which so seriously interfered with navigation. On account of the constant change in the width and depth of the river, and its irregular descent, its cross currents, eddies, whirlpools and rapids, a skipper required the greatest personal courage and caution to take a vessel down the stream, and as recently as 1862 a Turkish war vessel, the Silistria, foundered here. The improvements made before 1830—for example, the road built along the bank between Báziás and Orsova—were insufficient, and a plan worked out four years later by the Hungarian engineer Paul Vásárhely, on which all after work was based, remained on paper in spite of its excellence; but, thanks to his energy, a canal 393 feet 8 inches long and 104 feet wide was blasted in the rocky bank of Izlás-Tachtalia during low water in the years 1834 and 1835.

The Berlin congress of 1878, which followed the last Turko-Russian war, started the work on the Danube. By Article 57 of the Berlin treaty of 1878, to Hungary alone was intrusted the charge of the work, while on the other states along the river was imposed simply the duty of promoting the work in every possible way. Hungary undertook to pay the expenses, provided she was granted the right to levy a tax on the navigation of the river. The Hungarian Minister of Commerce, Gabriel Baross de Belus (to whom Hungary owes the change in her trade regulations and the development of her trade and industry), after a careful study of the plans submitted, determined to put them in operation. The final plans by means of which the obstacles to navigation were overcome and a navigable channel was obtained were most ingeniously drawn up by two great Hungarian constructors, Wallandt and Hosspotzky, who laid them before an international commission that recommended their adoption. In the year 1889, soon after the Department of Commerce had taken the matter in charge, two competitions were announced, one of which had for its object a system for the removal of rocks from under the water and the other a method of blasting. Very few of the total number of plans offered (seven and twelve respectively) were available.

The results of this competition were not such as to induce the Hungarian government to undertake the work, and therefore Minister Baross decided to assign the whole work to a company which should determine for itself the best methods of removing the rocks. By the contract of May 23, 1890, the work was given to a company which consisted of the Discontogesellschaft of Berlin, the firm of G. Luther (manufacturers of machinery) of Braunschweig, which had already won an honorable name, and the architect J. Hajdu, of Buda-Pesth, who, however, left the company at the end of the year. The chief condition imposed on the company by the contract of May 23, 1890, was that work should be completed by December 31, 1895, a very short time for such an undertaking. The official oversight of the building was given to E. Wallandt and A. Hosspotzky, the engineers who, as stated above, drew up the plans; while the mercantile part of the work was attended to by M. Ottermann, of Dortmund, who represented the Berlin Discontogesellschaft, the mechanical part by Hugo Luther, manufacturer and engineer, of Braunschweig, and the execution of local work was intrusted to Baudirector Rupschitsch, who had proved himself capable by having executed most difficult work on the Theiss.

They were gigantic obstacles which the contractors had to overcome, in order to fulfill their difficult and unparalleled task. In the autumn of 1890, the year that the contract was drawn, work was begun by Minister Baross, who ignited, by means of electricity, a charge of four tons which had been previously placed in the



BLASTING OF THE WALL THAT CLOSED THE SHIP CANAL, AFTER REMOVAL OF THE DAM, FEBRUARY 29, 1896.

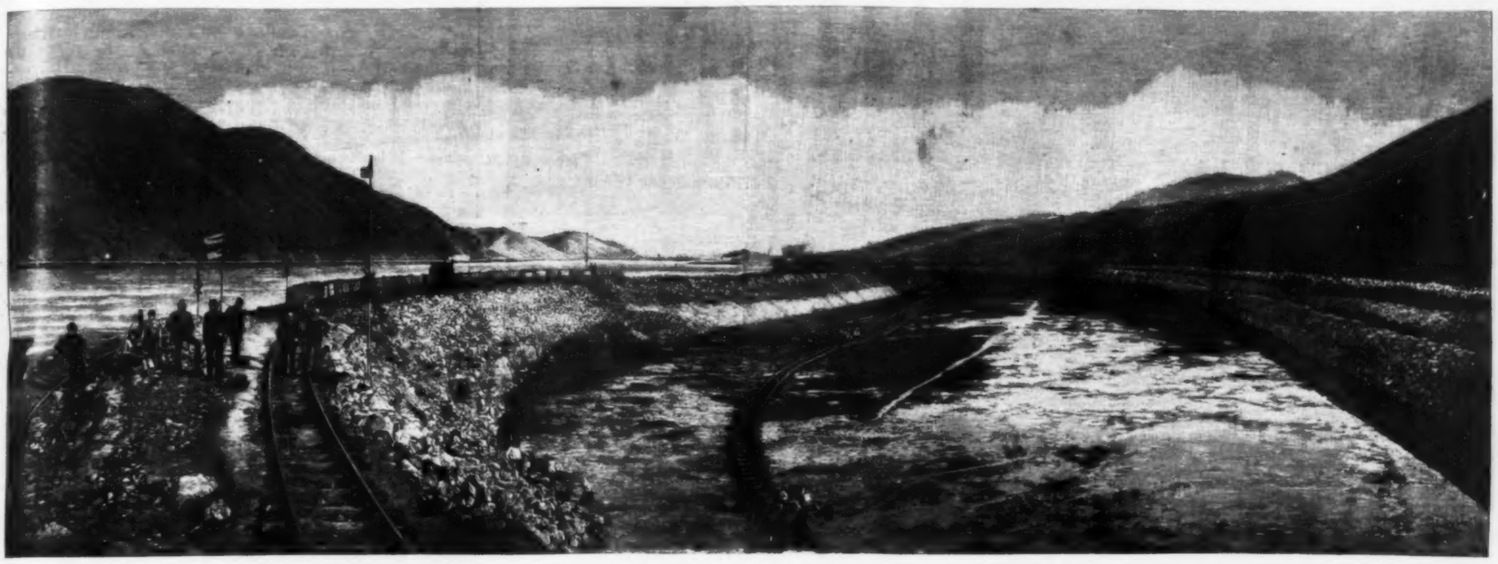
Grebenfelsen. In commemoration of this event a tablet was set in the rock at the upper end of the cataracts, near the colony of St. Helena, bearing the following inscription:

"The work on the cataracts on the lower Danube and the Iron Gate—ordered by Article XXVI of law—was begun on September 15, 1890, by Gabriel Baross de Belus, Royal Hungarian Minister of Commerce, during the reign of Franz Joseph I and the presidency of Graf Julius Szapary. God's blessing be on this work and its creators!"

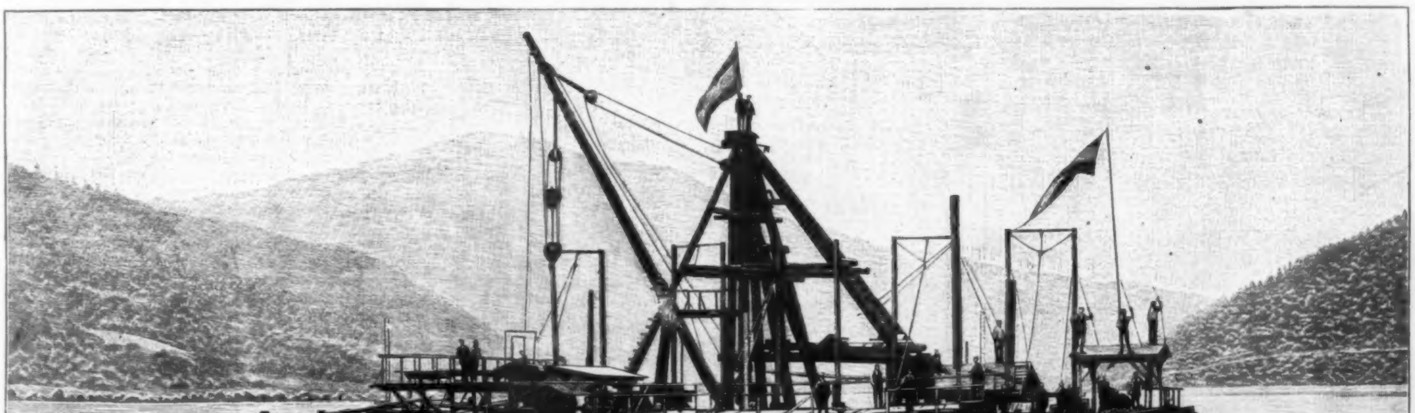
It was soon seen that special machines were required for work on that part of the river—a stretch of almost 62 miles—on account of the peculiar conditions of the ground. Almost two years were consumed in obtaining these machines. The apparatus which had done good service on the Suez Canal, the Isthmus of Panama and in the St. Lawrence River could not be used here. In three days $5,950 worth of black diamond points were ruined on the rock of the Juez cataract, which is as hard as steel; the great percussion drills were shattered, and at low water the boats bearing the drills were caught on the jagged rocks. A great many similar difficulties and vexations had to be encountered, so that it would not have been strange if less courageous contractors had given up an affair that seemed so uncertain.

But the energy of those in charge of the work increased with the difficulties to be overcome, and in a short time a feverish activity developed at the localities where work had been begun on the Danube, as well as in the designing rooms and machine shops of the Luther works, which was applied first to the construction of new machinery, durable percussion drills for use in blasting the rock, to providing the boats with more apparatus for blasting by dynamite, and to the proper removal of the debris from the river bed. The result was not a failure. Soon the banks and bed of the Danube presented an interesting picture. Near the localities where work was begun large quarries were opened and machine shops, blacksmith shops, railroad car factories, casinos, hospitals, etc., were erected. At the Iron Gate immense stretches of the river were inclosed by strong stone dams and the bed laid dry by the use of powerful pumps. Where once raging whirlpools had circled around dangerous crags, railroad rails were soon laid and locomotives drew long trains of stone-laden cars over them, the blow of the pickax sounded and dull detonations announced the explosion of dynamite. Where it did not seem feasible to draw off the water, boats carrying chisels were employed, the chisels on which, weighing from 8 to 10 tons, broke pieces of rock from the walls and crashed into the river bottom with irresistible force; and drills on boats were used for boring rows of holes for dynamite blasting. On account of the nature of the work, now and then, in spite of great care, men and material were lost by premature explosions. Before reliable igniting cartridges for use under water were secured, the dredges which followed the blasting apparatus were subjected to an additional danger from cartridges which had not ignited, and of which there were seven hundred at the Juez cataract alone. Finally, after many experiments, a separate igniting apparatus was employed for each hole drilled, so that on one boat there were as many as twelve igniting devices. After the holes had been drilled in the rock by an equal number of drills, they were filled with the explosive cartridges, and then the boat moved away and the electric wires connected with the cartridges ignited them. These wires were brought together in the electrical igniting apparatus and when the current was closed all of the cartridges were exploded at once. In individual cases charges of three tons, eight tons and even thirteen tons of dynamite were ignited; in the last case one explosion cost the trifling sum of about $7,600. But generally, and particularly when blasting under water, only small charges were used, so that the debris would be in proper condition to be removed by the buckets, scoops and grapnels of the dredges and used at once for building canals and dams.

To give laymen an idea of the great undertaking, which was completed even before the expiration of the time allowed and which greatly surpassed any similar enterprise ever known to history, we will give some details in regard to the apparatus used and the work accomplished. The cataracts begin 12 kilometers below the island of Moldova, in the neighborhood of which rise the ruins of the old Turkish fortress Golubatz. A canal 2,624 feet 8 inches long and 197 feet wide was carried through the upper cataract where the rock consisted of granite and micaceous schist, and 9,679 cubic yards of stone were blasted under water. For a second canal nearly one and one-half miles long, nine miles farther down the river, the removal of 86,328 cubic yards of micaceous schist from the banks at Lozla and Dojke was necessary. About five and one-half miles farther down the river were the rapids of Izlás, and very near them those of Tachtalia, where a canal one and one-fourth miles long was carried to Greben Point by the removal of 61,476 cubic yards of porphyrylike limestone. 522,300 cubic yards of stone were removed from the nose of Greben Mountain, which projected into the water so as to narrow the river to a width of only 1,475 feet. Just behind the Greben rocks there was a great whirlpool 164 feet deep, where the Danube widens so much, near the Servian village of Milanevatz, that a stone dam 208 feet 6 inches long had to be built to make the river narrower, but which, for the sake of safety, was kept so low that at high water the river goes back into its old bed, which is about a mile and a quarter wide; furthermore, to make the dam safe and also to prevent cross currents on the Servian bank, two cross dams (supporting dams) were constructed. Again, two and one-half miles farther down, a little above Orsova, is the fourth cataract, where a bank of uncommonly hard rock (granite, porphyry, serpentine, quartz and diabase) extends across the river like a gate, and from which 4,185 cubic yards of stone had to be blasted in order that a canal 4,265 feet long might be built, and a dam nearly two miles long was constructed for narrowing the channel. Six miles below that dam the channel, which has thus far been 3,280 feet wide, is suddenly narrowed to 328 feet by high mountains. This would have created a raging current that would have carried death to every living thing if the river had not been so deep at this point, where it has a depth of 164 feet. Here, at Kasan, where the river narrows, the beauty of the scenery is historical; here the path made more than eighteen hundred years ago by the Romans extends along the bank; and here the celebrated Trajan's tablet still tells of the power

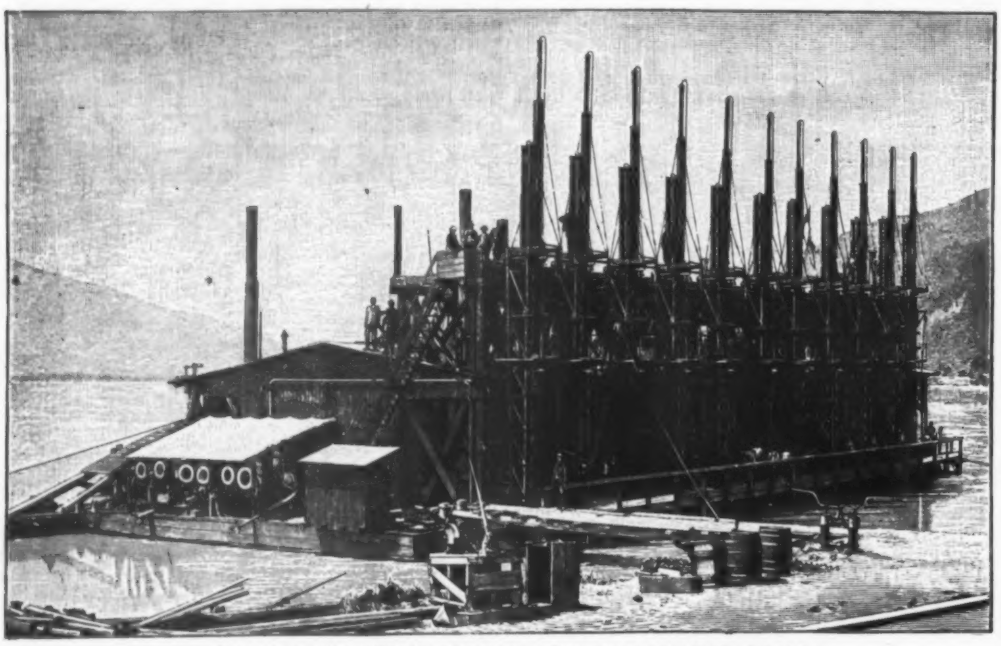


THE CANAL COMPLETED.

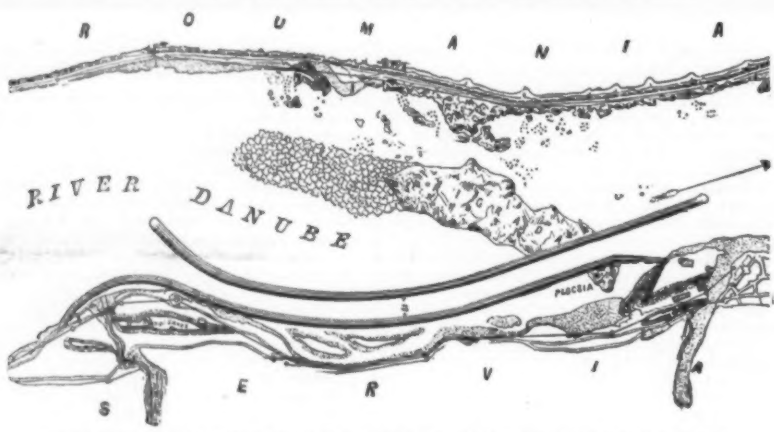


BOAT FOR GENERAL WORK.

and greatness of the emperor. We pass the town of Orsova, a third of whose inhabitants are German Catholics, the headquarters of the company, the Turkish island castle of Adakeleh, built in 1878, and still occupied by the Turks, and finally, seven and one-fourth miles farther down the river, we come to the most dangerous of the rapids in the Danube, to Demirkapu, the Iron Gate, where, after pumping the bed dry and blasting out 497,040 cubic yards of rock, a canal 262 feet wide was built by means of two dams, which are one and three-fourths miles and one and one-half miles long respectively. The water rushed over innumerable points of rock which were scarcely visible at high water, as if the whole were a devil's caldron, in which he wished to boil the old rocks. "Did the rushing mass of water once break a passage for itself, or did the heat of the earth's internal fires cause the mountain chain to part?" This question is asked by the Hungarian poet Maurus Iokai in his great romance, "Der Goldmensch" (The Man of Gold). Did Neptune or Vulcan perform this work, or was it done by both together? In any case it was a work worthy of the gods. "It is," so continues the poet, "as if we approached a temple built by giants with pillars that consist of blocks of stone, and with columns as high as towers, which rise like wonderful colossi to the vanishing frieze above, in which fancy places statues of the saints. And this temple hall extends in a perspective, four miles long, it curves, meanders, and displays new domes with walls grouped in various ways, and other wonderful formations. One wall is as smooth as polished granite; red and white veins run through its entire length like characters of a mysterious writing of the gods. In other places the whole of the rocky page is reddish brown, as if it were of solid iron. Here and there the diagonal strata of granite bear witness to the bold methods of construction employed by the Titans; at a new turning the portal of a Gothic cathedral comes before us with pointed towers and slender basalt pilasters placed close together, and a golden spot shines on the smoky wall like the tablets in the Ark of the Covenant; that is where the sulphur bursts forth like a flower. But the walls also abound in living flowers, they hang down from the cracks like green wreaths held by pious hands, and those are gigantic trees over whose dark masses are scattered red and yellow garlands of sunburned bushes. Now and then the endless line of double walls is interrupted by a ravine which gives a glimpse of a hidden paradise uninhabited by men." Thus Maurus Iokai vividly and poetically describes the cataracts of the Danube.



DRILL BOAT, WITH ELEVEN STEAM-OPERATED DRILLS.

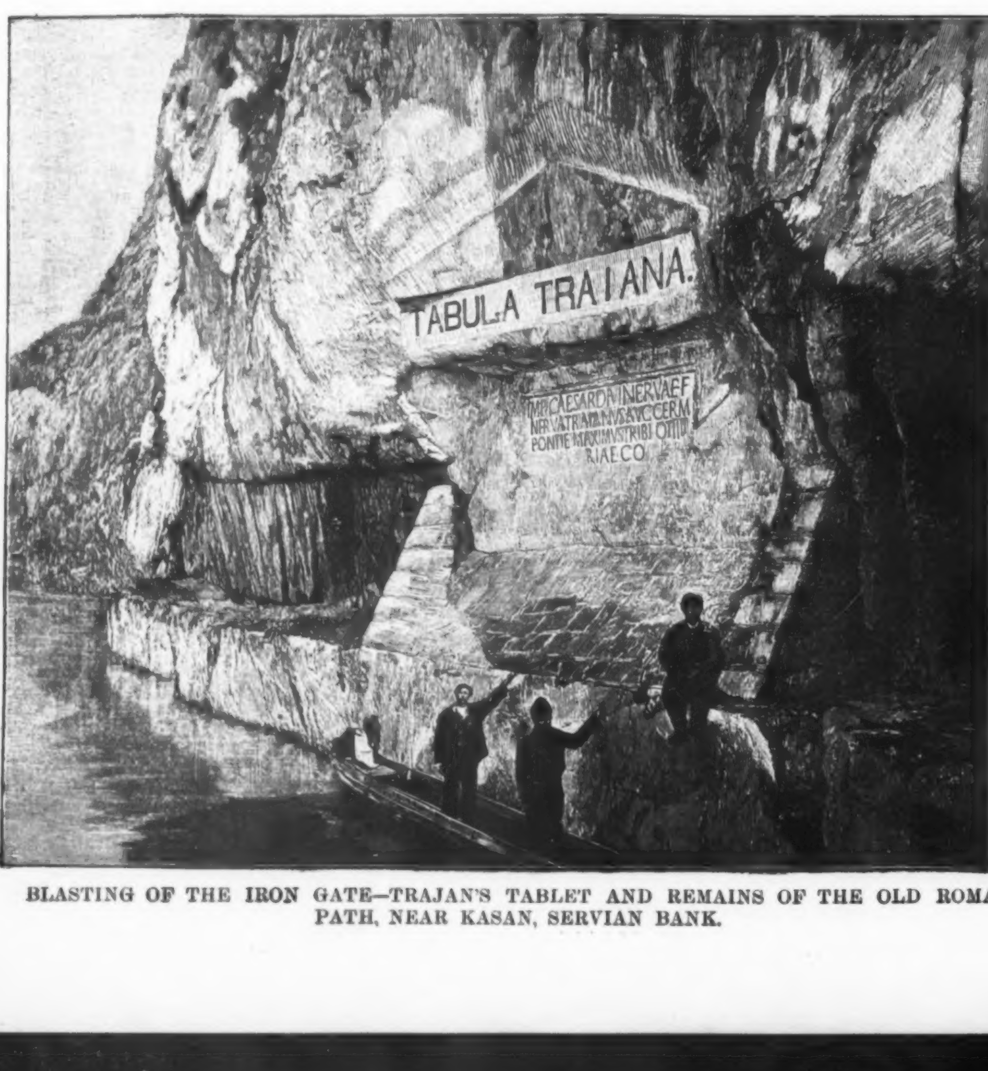


DANUBE: THE OPENING OF THE IRON GATES—PLAN OF THE CATARACT AND THE NEW CHANNEL.

And in this grandly beautiful but dangerous masterpiece of the gods a breach has been cut—making a navigable channel for commerce—in the short period of less than six years, by the modern man, with his new explosives and ingeniously constructed machines. In doing this work he has made for himself and his highly developed technical art at the end of this nineteenth century a glorious memorial to go down to succeeding generations. But with what wonderful apparatus has the bed of the Danube been worked upon day and night! Under the direction of about forty engineers of the company and a number of engineers who superintended the work for the state, there were—aside from those employed at the industrial and other plants mentioned above—nine thousand workmen using thirty boats for sounding, blasting and dredging, besides five boats for general work, used in finishing off the river bed. One of these boats would be taken over the portion of the bed that had been blasted after the debris had been removed and the frames that hung down from it like pendulums would indicate, by a visible movement, any points of rock that had been left standing. These were broken off by means of heavy drop chisels operated by cranes and the debris removed from the river bed by means of the grapnels of the cranes. Besides these there were ninety-two stone prams, five floating and three portable cranes, nine locomotives and 1,400 railroad cars used on the work. The work accomplished by means of this enormous amount of apparatus might be estimated in round numbers at 1,635,000 cubic yards of rock removed, 915,600 of which were removed under water. The reader can get at the true meaning of this by another calculation; it took two years to remove the stone from the bed of the river and carry that needed for the dams, although a train of eighty large double cars loaded with stone was sent off each hour of every working day. This is not the proper place to discuss the technical details of the work, but a few statements in regard to what was accomplished by one boat during a working day of twenty hours might be of interest even to the laity. An old boat provided with three drills blasted 58·3 cubic yards of rock, a new one constructed by G. Luther with four drills blasted 84·7 cubic yards, and the average for each boat was 14·22 charges, one charge blasting 4·93 cubic yards of rock in an hour and twenty-four minutes; 81 to 83 cubic yards of stone were broken off each day by the drop chisels, the average number of blows of each chisel, per day, was 1,565·22; 0·05 cubic yard of rock being broken off at each blow; that is, in forty-six seconds. The capacity of the dredges was also very great; for example, the great bucket dredge, Vaskapu, removed 224·3 cubic yards, the scoop dredges 83 to 113·2 cubic yards, and a grapnel dredge 8·5 cubic yards of stone. But to get at the amount of work really performed by these various machines the figures given above must be increased by about 100 per cent.

And so this immense piece of work, the blasting of the Iron Gate, which the company undertook with so much confidence, was accomplished in an incredibly short time, even before the expiration of the time allowed by the contract. It seems unfortunate that the energetic promoter, Minister Baross, did not live to see the completion of the work, a triumph of human energy and the modern spirit of invention over nature. He died May 9, 1892, when only forty-four years old.

The blasting of the cataracts of the Danube by means of most ingeniously constructed apparatus has been the occasion of a rapid advance in our technical and engineering science as applied to the construction of machinery and the improvement of its quality. Prof. Arnold acknowledges that the difficulties of the undertaking passed from the hands of the marine constructors to those of the machine makers: but they had to work together with untiring patience to accomplish the difficult task set them. Much depended upon the official heads as well as on their self-sacrificing collaborators. When such powers work together harmoniously, as in the case of the blasting of the Iron Gate, the saying of the Emperor, "The world has reached the age of commerce," is realized as a blessing to the nations that enjoy friendly trade relations and a peaceful competition.—Illustrirte Zeitung.



BLASTING OF THE IRON GATE—TRAJAN'S TABLET AND REMAINS OF THE OLD ROMAN PATH, NEAR KASAN, SERVIAN BANK.

The first cast iron bridge in Germany was cast in 1794 and completed in 1796. The span was about fifteen yards, and the height three yards. About the same time a cast iron bridge of seven yards span was built in Berlin, and an engineer wrote as follows about this bridge: "Experience will show if, as would be desirable, iron girders can also be used for bridges of greater dimensions."—Glaser's Annalen.

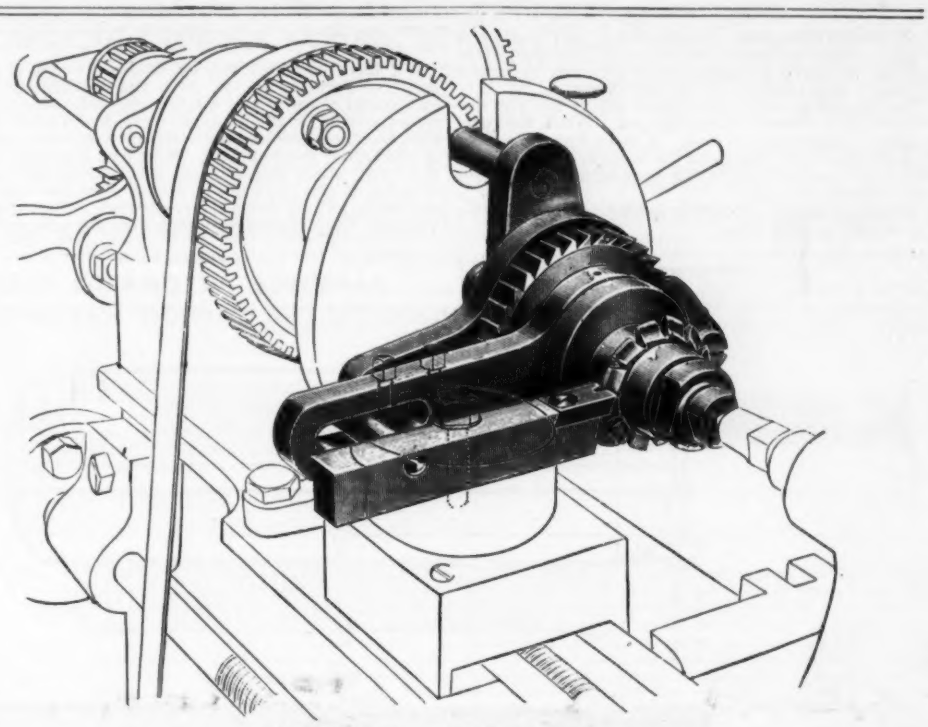
MACHINE WHICH, WITH A PORTION OF THE WATER OF A SPRING, RAISES ANOTHER PORTION TO A CONSIDERABLE HEIGHT.

A WELL, A, must be dug beneath the source, B, and care must be taken to make its depth equal to the distance from the discharge of the source to the point to which it is desired to raise the water. Then, after a tower of wood or masonry has been constructed over the well, and the reservoirs, C and D, have been put in place, one of them at the discharge of the source and the other at the top of the tower, the two chains of buckets, E F and G H, are suspended from the large drum, I. The chain of buckets, E F, which is half the length of the other, is placed perpendicularly over the reservoir, D, from which it is to draw water, while the long chain, G H, is so placed that its buckets shall receive the water discharged from the reservoir, D, and empty it after they have reached the bottom of the well.

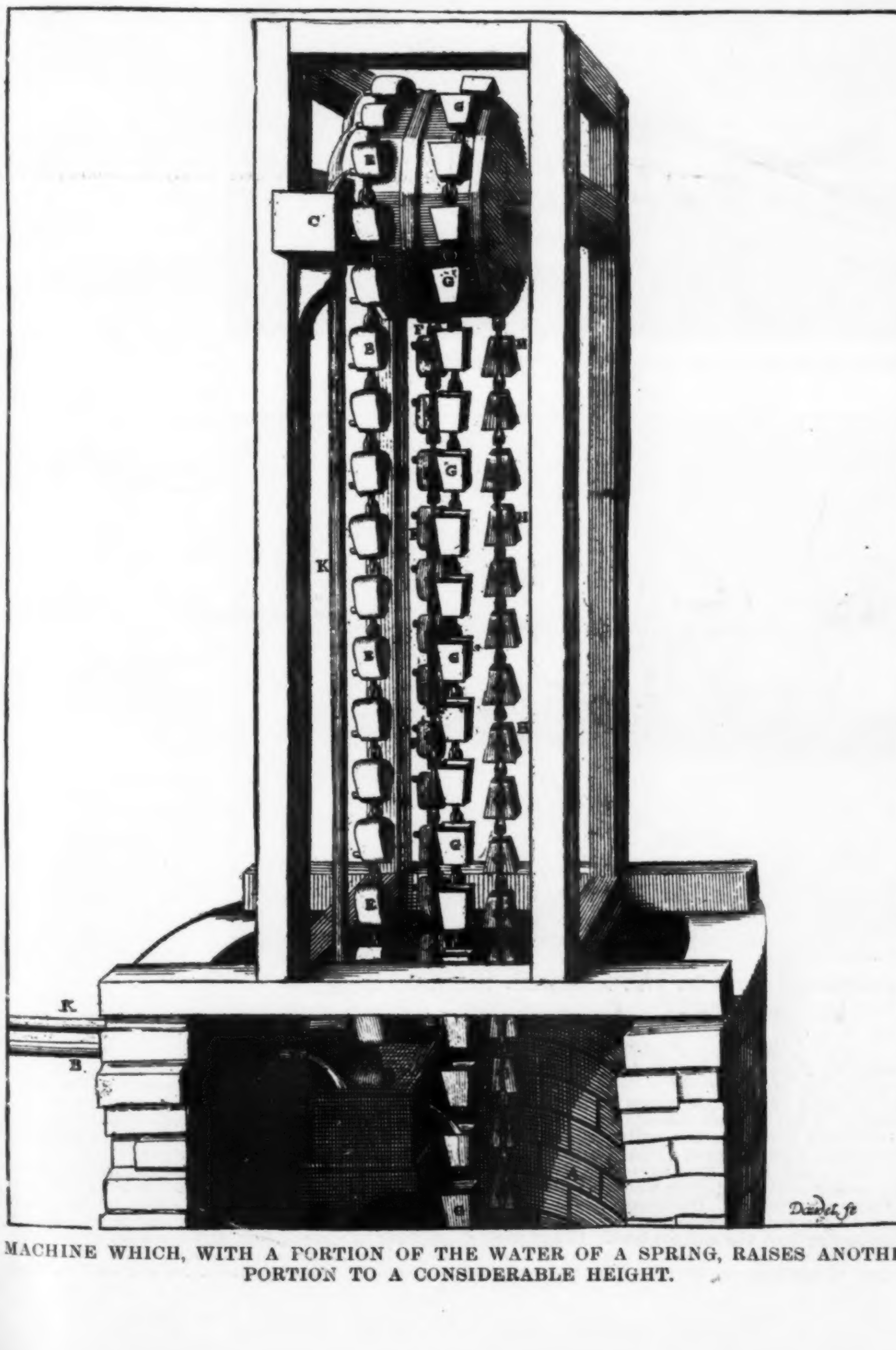
In measure as the buckets, G, become full, the weight of the water that they have received causes them to descend; and, as they are a little larger than the buckets, E, and consequently heavier, they, upon filling, cause the ascent of the latter, which, having become full of water in passing into the reservoir, D, empty the liquid into the reservoir, C.

In order that the buckets, G, which properly form the counterpoises that set the machine in motion, may cause the drum, I, to revolve, and that the latter in its revolution may raise the buckets, E, when they are full and cause them to pass in succession one after the other, the circumference of the drum must be provided with flat faces instead of being rounded, and the links of the chains must be of the length of such faces, so that the chains shall not only closely embrace the drum, but that the angles of the different faces shall prevent the chains from slipping around the circumference.

As regards the buckets, E and G, they should be of different form, according to the two purposes for which they are used. The buckets, E, which are to carry water to the reservoir, C, resemble boxes closed on every side, and are provided with a small aperture at the lower part, into which enters a short tube. The buckets, C, are different from the ordinary ones, in that their mouth is wider in every direction than their bottom, in order that the water discharged from the reservoir, D, may fail into them more easily. In order that the two chains of buckets may not get out of place upon the drum, I, the latter is provided with three hoops, one in the center, to separate the two chains, and one at each end. In this way, without the two chains being interfered with, they are prevented from deviating to the right or left. The water raised to the reservoir, C, may be led through the pipe, K, to the place where it is desired to use it.—From Recueil d'Ouvrages Curieux, 1733.



NEW LATHE ATTACHMENTS.



MACHINE WHICH, WITH A PORTION OF THE WATER OF A SPRING, RAISES ANOTHER PORTION TO A CONSIDERABLE HEIGHT.

NEW LATHE ATTACHMENTS.

IN the accompanying engravings, for which we are indebted to London Engineer, are represented two improved devices, which will be found useful in machine shops. That shown in Fig. 1 is an ingenious appliance for fixing in the tool post of a lathe for hacking off milling cutters in a quick and simple manner. The blank roughed out, ready annealed, and with the slots cut, is placed on the arbor as shown, while the tool having the desired shape of the teeth truly cut out is held securely in the rest and fed forward by the usual cross

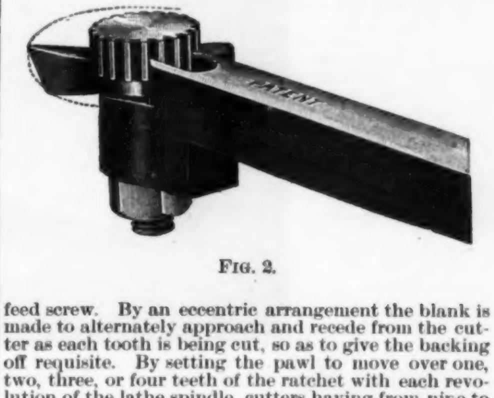
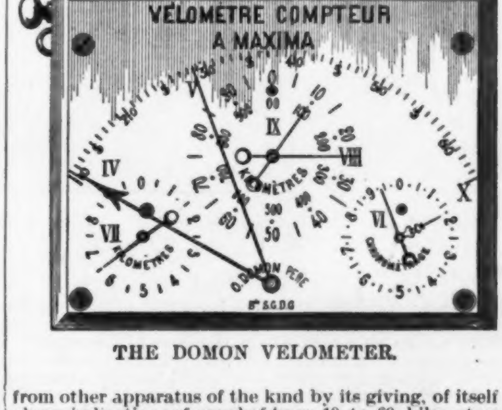


FIG. 2.

feed screw. By an eccentric arrangement the blank is made to alternately approach and recede from the cutter as each tooth is being cut, so as to give the backing off requisite. By setting the pawl to move over one, two, three, or four teeth of the ratchet with each revolution of the lathe spindle, cutters having from nine to thirty-six teeth may be operated upon. This setting of the pawl is effected by simply loosening a nut and altering the throw of the eccentric. The appliance is substantially constructed, and should prove very useful, while the backing off is such that the cutter can be ground without alteration of shape. Fig. 2 shows an improved holder for tools employed in lathes, planing and shaping machines, whereby the tool is more securely held than in the case of ordinary holders, and can be swiveled through a large angle by unscrewing the nut shown below the device. It will be seen that the serrated head holding the tool engages it with the forked end of the holder. Messrs. Selig, Sonnenthal & Company, 85 Queen Victoria Street, are introducing both the above appliances in England.

DOMON'S VELOMETER.

THE new speed indicator illustrated herewith is, as explained by its inventor, Mr. O. Domon, distinguished



THE DOMON VELOMETER.

from other apparatus of the kind by its giving, of itself alone, indications of speed of from 10 to 60 kilometers an hour and of a run of 1,000 kilometers, which usually requires the use of several instruments. The distances are indicated with precision by jumping hands and not by trailing ones. What is called a hectometric hand permits of estimating fractions of a hectometer, even.

By means of an auxiliary hand, the placing of which

at zero is instantaneous, it is possible at any instant of a trip to make an exact verification. The parts that indicate the speed are regulated for all cases by means of electric apparatus of the highest precision.

The placing at zero is effected at will by the sole motion of a slide closed by a spring lock. When the latter is open the regulation is easy. A steel wire, protected by a metallic tube, transmits the motion of the driving wheel to the wheelwork of the apparatus through the intermedium of a cam.

This apparatus is applicable to all kinds of vehicles—automobile or otherwise.

In the accompanying figure the hand that moves over the large upper dial indicates the speed, that varies according to the running. Upon the same dial another hand marks the maximum speed reached, and remains upon the highest figure until it is moved back by a button situated at the lower part of the apparatus.

The dial to the right carries a hectometric hand having a slow motion, and also a verifying hand. Upon the dial to the left there is a hand that marks the units of kilometers. Finally, upon the central dial there are two hands, one of which gives the tens and the other the hundreds of kilometers.—La Locomotion Automobile.

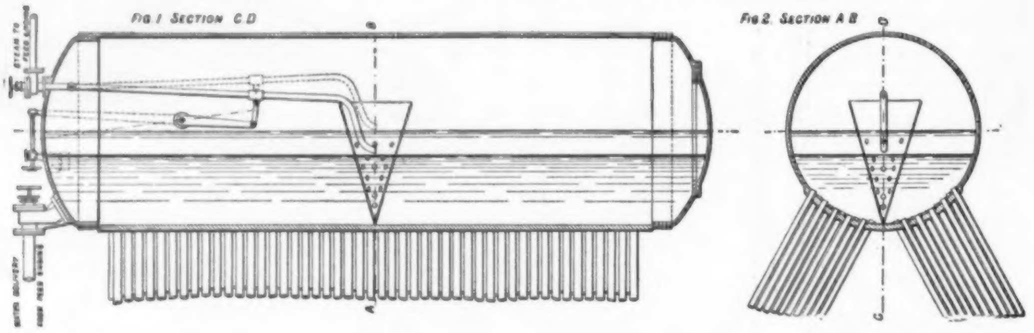
AUSTRIAN TORPEDO BOAT VIPER.

WE have been favored by Messrs. Yarrow & Company, of Poplar, London, with the accompanying illustrations of the Viper, a large seagoing torpedo boat recently built for the Austrian navy, and a set of water tube boilers constructed for use in some new cruisers of the Dutch government. The Viper is 147½ ft. long, 14 ft. 9 in. beam, and was guaranteed to attain a speed of 24 knots with all loads on board. On her trial trip she exceeded this by 2·6 knots per hour. Her seagoing qualities were thoroughly tested on the passage from the Thames to Pola, as she encountered very rough weather in the Bay of Biscay.

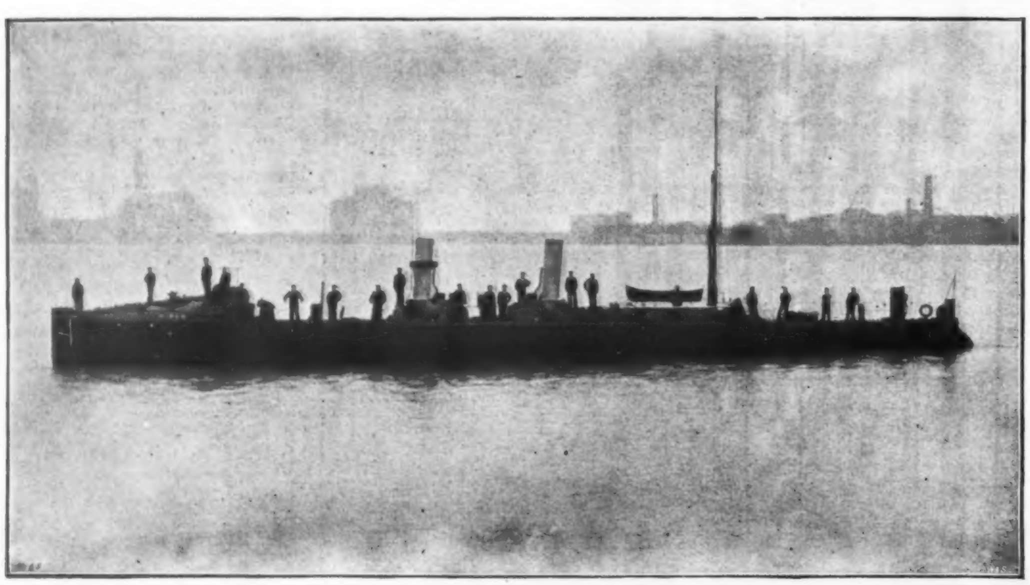
The great speed of the Viper raises the question as to the ability of the average torpedo boat destroyer to overtake such a craft under ordinary conditions. The recent English destroyers of the Ardent class have 27 knot speed, or only half a knot more than the Viper. The only conditions in which they would be certain to overtake her would be in heavy weather, when their greater length and weight would enable them to hold their speed better than the smaller boat. In any case the advent of such a torpedo boat as the Viper shows the wisdom of building destroyers of 30 knot speed and over. The Viper is a single screw vessel, the engine indicating from 1,900 to 2,000 horse power. We may remark in passing that the rapid rise in the power of these vessels for a relatively small increase in speed is shown by the fact that the 27 knot destroyer requires 4,000 horse power and the 30 knot destroyer 6,000 horse power to drive them. The torpedo armament consists of revolving deck torpedo tubes for firing over the sides, one aft and two forward. There are also two 47 mm. rapid firing guns placed forward, one on each side of the conning tower.

The engraving of the Dutch boilers shows them complete as they stood ready for shipment to Holland. They are to be placed in three cruisers, the Friesland, Holland and Zeeland. There will be eight water tube boilers and two of the common return tube type in each ship. The water tube boilers are of the standard Yarrow type, with straight tubes. They are built according to the theories of water tube circulation which Mr. Yarrow so clearly proved in his recent experiments. The tubes are straight, which enables them to be readily cleaned out and examined internally. It is a cheap form of construction, and the number of spare tubes required to be carried, as they are all straight, is much less than when the tubes are curved to various

YARROW'S AUTOMATIC FEED
AS APPLIED TO THE YARROW WATER-TUBE BOILER.



YARROW WATER TUBE BOILERS FOR THE DUTCH NAVY.



SEA-GOING TORPEDO BOAT FOR THE AUSTRIAN NAVY.

Speed, 26·6 knots per hour.

forms. The feed apparatus shown in the engraving is thus described by Messrs. Yarrow:

"The pumping engine supplying the boiler obtains its steam from an internal steam pipe which terminates, not, as usual, at the upper part of the boiler, but near the required water level. If the water is below that level, steam passes into the pump, which is actuated at a high velocity, forcing water into the boiler. Immediately the water rises to the normal level, and upon its coming up to or above the orifice of the internal steam pipe, water passes into the steam cylinder of the pumping engine, and the pump works hydraulically, rapidly slowing down. If the boiler be too full of water, the pump still works slowly, and extracts from the boiler the surplus water to the extent of the difference of the capacity of the steam and water cylinders respectively, until the level in the boiler is corrected. Thus it will be seen that with this system not only is the water, if low, immediately raised to its proper level, but if too high, it automatically lowers. Means are adopted for raising and lowering the internal steam pipe leading to the steam pump, so that any desired height of water can be maintained to suit various conditions of working."

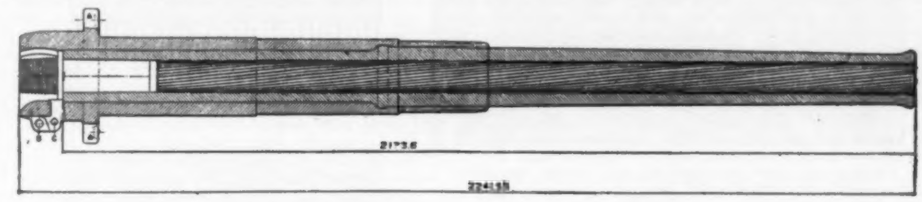
The arrangement is simple and should be very effectual. Automatic feed, for very evident reasons, should be thoroughly reliable. When the fireman knows that a boiler is provided with a device for automatic distribution of feed, he will unconsciously relax some of his vigilance, and if the mechanism be intricate and liable to get out of order, there is constant danger of disaster.

FRENCH QUICK FIRING FIELD GUNS.

ONE of the points which occupied the attention of Li Hung Chang, during his recent tour through Europe, was the progress made by different nations in the development of quick firing field guns. It is said that he was, at St. Chamond, in France, initiated into the mysteries of the new French field artillery of this character, which is interesting scientific gunners so much at present. The application of the quick firing principle to field guns of ordinary caliber, although an idea of somewhat recent growth, has been the dream of enthusiastic artillery officers, and of the large war material producing firms, ever since its success was so entirely assured in regard to naval guns. But the difficulties appeared to be insurmountable. The jump and recoil of a field gun seemed to be inseparable features attaching to its employment. Then there was the prejudice against carrying ammunition fitted with primers in limber boxes; and however one might reconcile one's self to the dangerous character of this last condition, the fact that a very slight movement of the gun in recoil destroyed the elevation and training was fatal to the application of the principle, unless the movement could be absorbed. Messrs. Gruson, of Magdeburg, expeimented for years with quick firers of various types, having calibers up to 8 centimeters, and an elaborate system for correcting the deviation in direction caused by recoil, the weight of the carriage being greatly increased by that of the mechanism required; but it was found that the carriage, even when perfectly skidded, ran back nearly a meter, and that it was only with much smaller calibers that the recoil could be absorbed within manageable limits.

In our own country we do not think that the system has hitherto had a fair trial. So great is the feeling of field and horse artillery gunners against any innovation from perfect simplicity in the form and design of guns and carriages for their arm of the service, that the very fact of a gun being slung in a cradle, and without trunnions, and of its carriage being provided with recoil cylinders and running out springs or training segments, would be sufficient to condemn it in the opinion of many commanding officers of field or horse batteries. Nevertheless, it goes without saying that the army of the future which is provided with an artillery armament of satisfactory quick firing field guns, and an ample supply of ammunition, will possess an element of dire and terrible potency, against which ordinary field guns, firing their conventional one or one and a half rounds per minute, would be absolutely nowhere.

Under these circumstances it is satisfactory to learn that efforts are being made by private manufacturers in this country to supply the much needed quick firing field gun. We have, by the courtesy of the Maxim-Nordenfelt Company, been enabled to produce in our columns this week engravings of their quick firing field gun of 7·5 centimeters, which was fired, with remarkable success, upon the company's shooting ranges at Erith, in the presence of Li Hung Chang. We have also been furnished with the following particulars in regard to the gun.



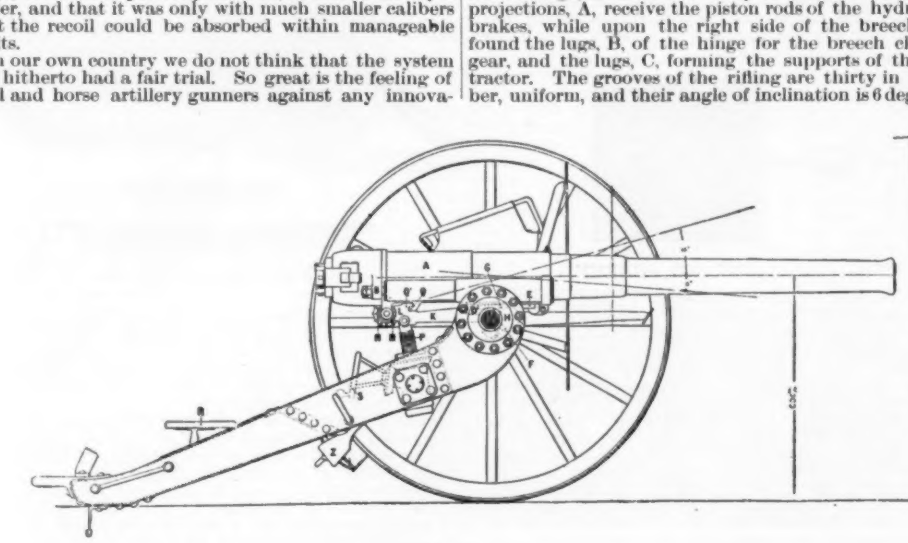
The principal data which have served as a basis in the design of this novel weapon are briefly:

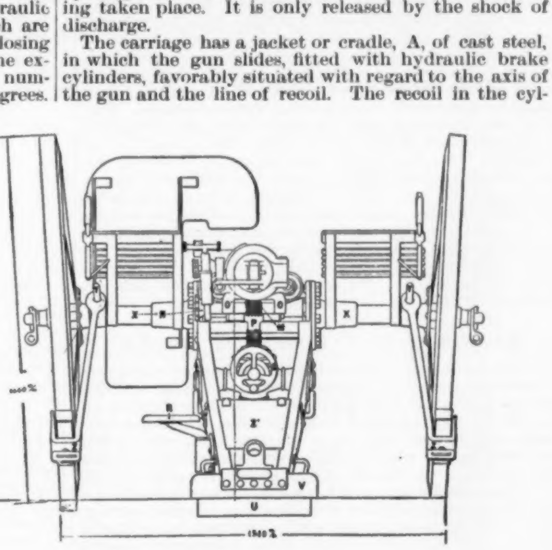
The employment of fixed ammunition with primed metallic cylinders. Closing of the breech with an interrupted screw, of great simplicity, of rapid and easy manipulation, composed of massive parts, and absolutely assuring extraction of the empty cartridge cylinders. Facilities for dismounting, without any tool, of the firing and breech closing mechanism, admitting of the immediate change of a "striker," or of its spring. Recocking the gun without opening the breech. The employment of hydraulic brakes, absorbing part of the recoil, and reduction of the "jump" of the carriage. Separate gear for training and elevation to be worked by the "laying number" who sits on the side of the trail; he also to fire the gun. Automatic brakes of great simplicity on the wheels. A light steel shield to protect the "laying number" against rifle bullets or shrapnel. Total weight of "heavy equipment" drawn not to exceed 3,968 lb. Total weight of "light equipment" drawn—for horse artillery—not to exceed 3,307 lb. Employment of a single projectile, with a few rounds of case shot.

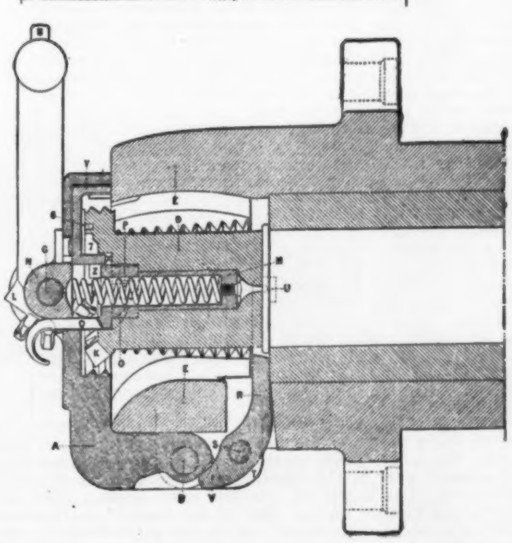
The gun is of the ordinary tempered steel type. Being intended to slide in a cradle, which forms part of the carriage, it does not carry trunnions. The two projections, A, receive the piston rods of the hydraulic brakes, while upon the right side of the breech are found the lugs, B, of the hinge for the breech closing gear, and the lugs, C, forming the supports of the extractor. The grooves of the rifling are thirty in number, uniform, and their angle of inclination is 6 degrees. Their width of 5·8 mm. at the commencement diminishes gradually to 4·9 mm. at the muzzle, causing a continual compression of the driving ring during the passage of the projectile through the bore of the gun, which diminishes the chance of gas escape and consequently of erosion. The depth of the grooves is 0·58 mm.

The breech closing gear is somewhat different to any hitherto employed. The breech screw, D, is actually conical, but the largest diameter is at its interior extremity. Nevertheless, it hinges out upon the carrier, A, without any longitudinal movement being required, the seating, E, being sloped away to a certain extent to admit of this. This arrangement is said to obviate all possibility of the breech gear being forced out by excessive pressures. The extremity of the manipulating lever, F, has a segmental pinion, I, engaging with a cogged segment, K, in the breech block. The first portion of the movement then makes the block revolve and unscrew 90 degrees, the cogs of the pinion being placed eccentrically to its axis, so that they recede as the block goes out and preserve their engagement. A claw on the pinion now sets against the breech block and brings it out, instead of making it revolve further. The 90 degree revolution brings the threaded portions of the screw against the smooth portions of the seating. The striker, M, is actuated by a spring pressing between the sleeve, N, and its solid point. Turning the breech block presses the two helicoidal surfaces, O, upon projections, P, behind the striker, and cocks the gun, the striker itself being prevented from rotating by the directing arm, Q, which can only work longitudinally. This directing arm is prolonged beyond the carrier and ends in a hook, by which the gun can be recocked in case of a misfire without opening the breech. The extractor, R, oscillates around an axis, S, fixed in the two lugs, T; it has two extracting claws, V. By the movement of the curved heel, V, the process of extraction, slow at first, finally ejects the empty cartridge cylinder with a jerk. The ordinary trigger mechanism is seen at X Y Z and the firing lever, 2. A safety trigger, composed of a heel at the end of the prolongation of Y, slides in the groove, 5, and prevents the act of firing until the moment when the breech is closed. The breech block is prevented from oscillating unduly around its axis by a spring button, 7. A bent lever, actuated by a spring, something like the brake on a bicycle handle, secures the working lever of the gun in its position against the breech when closed. The breech closing gear is provided, when required, with an arrangement for preventing the opening of the breech in the event of a hang fire having taken place. It is only released by the shock of discharge.

The carriage has a jacket or cradle, A, of cast steel, in which the gun slides, fitted with hydraulic brake cylinders, favorably situated with regard to the axis of the gun and the line of recoil. The recoil in the cyl-







THE NEW FRENCH QUICK-FIRE FIELD GUN.

inders is 12 in. The gun jacket and hydraulic brake are upon a semicircular platform, E, being secured by the clamps, D and D¹. The pivot, E, is the center of movement of the whole system for a training of 9 degrees. The lower part of the pivot, F, and the cushion, G, work by a screw upon the fixed cylindrical axis, H, secured to both brackets of the carriage. It will be seen, by a reference to the drawing, that the axis of the gun is low down, and very near the center of the axletree, and consequently that the angle of the trail is a very acute one, if the wheels are of the ordinary height. This is a great advantage, as it prevents jump. A cogged segment, L, engaging with the endless screw, M, manipulated by the training wheel, N, gives training through an arc of 9 degrees without altering the position of the trail. The elevating screw and wheel can be seen at P and S. They admit of 15 degrees of elevation and 5 degrees of depression. The sights are fixed upon the side of the jacket, and consequently do not recoil with the gun. This is a manifest advantage. The training and elevating wheels are so placed that the "layer," seated upon the seat, R, can without any inconvenience elevate, having the right hand upon the wheel, S, while with the left he works the training wheel, N. The elevation once obtained, his right hand is free to pull the trigger and fire the gun. The extremity of the trail is provided with a short spade, U, for the purpose of further checking the recoil, fixed beneath a plate, V, sufficiently large to prevent the burying of the trail in the ground. The axletree carries at each side, near the wheels, a ring, Y, the position of which is slightly eccentric in regard to its axis, each ring receiving the end of a drag iron, Z, intended to skid the wheels during firing. These drags are in all respects automatic, for the more the wheels have a tendency to turn during recoil, the more firmly are they skidded. On the march the drags are hung at either side of the trail. Z¹ is a trail box for tools, sights, spare parts, etc. The carriage is provided with a steel shield, 6 mm. thick, of special quality, resisting rifle bullets at a distance of 20 meters.

The following are the principal dimensions and particulars which should be noticed:

	Heavy gun.	Light gun.
Caliber of gun—7·5 centimeters.	2·95 in.	2·95 in.
Length of gun	30 calibers	24½ calibers
Weight of gun and breech gear	734 lb.	624 lb.
Height of axis of gun above ground	36·34 in.	35·25 in.
Weight of the carriage with wheels	1,828 lb.	1,431 lb.
Angle of recoil upon the ground	30 degrees	30 degrees
Weight of loaded projectile—shrapnel	13 lb.	11¾ lb.
Weight of round complete of fixed ammunition	16 lb.	14 lb.

The fixed ammunition is loaded horizontally in limber boxes, thirty-six rounds being carried with the heavy gun equipment and forty-eight rounds with the horse artillery equipment, upon the gun limber. The initial velocity with the heavy gun is about 500 meter seconds.

The above is a very much curtailed description of this new quick firing field gun, which appears to answer the majority of the requirements demanded by modern horse and field artillery. It is wonderfully light, well placed on its carriage as to recoil, and the entire weight behind the team considerably less than that carried by our horse and field batteries. One of the principal questions which occurs to us is the supply of ammunition to the quick firing field gun of the future, as the limber boxes are exhausted. With rapid work the gun limbers and ammunition wagons would be emptied in a very short time, and the arm would be helpless if there were no reserve handy. This point has, however, nothing to do with the efficiency or non-efficiency of the gun we have been describing. It worked with the utmost smoothness at Erith, in the presence of Li Hung Chang, and the difficulty of recoil appears to have been grappled with in the most masterly manner, without unduly increasing the weight of the carriage. Of course, the spade would not strike into the ground if there happened to be solid rock beneath the trail, but this would probably be an unusual circumstance. We are indebted to the London Engineer for the cuts and article.

MARBLING THE EDGES OF BOOKS.

In the production of marblelike designs on the edges of books (and also on sheets of paper) much depends on having a suitable ground or size for the reception of the colors. Such a ground consists of a gelatinous substance and water forming a viscous fluid, which will not absorb the solutions of color—to which gall has been added—but will allow them to float on it, so that the colors can be removed on a smooth surface without disturbing their peculiar stratification. Boiled carragheen moss or gum tragacanth dissolved is generally used for the size, and if thin, fluid colors which have been mixed with gall are sprinkled on it, the gall causes the drops of color to spread and finally run into one another if the drops are large enough; the more gall there is in the colors, the more the drops will spread. If the drops of color are left undisturbed and a sheet of white paper is laid on the fluid and then immediately removed, the colors will be fixed on the paper while the gelatinous fluid taken up with them will run off. If a style is passed perpendicularly through the layer of color into the size (the ground on which the colors float), the colors will combine and will follow the style, but will not mix with the size. If a comb is passed through the layer of color—color carpet, as it is called—the colors which lie close together in waves will be divided without the mixing of the different shades, the chosen design remaining unaltered long enough for the operator to take it off on the edges of a book or on a sheet of paper. The greater the number of colors sprinkled on the size the more varied the color carpet will be, of course, and the greater the contrasts of color, the more dazzling the marble of the design produced. Care should always be taken to choose colors that will harmonize.

If soapy water is sprinkled, by means of a rice straw brush, on a very weak color carpet of two or three colors, the colors draw together in fine veins, leaving the greater part of the surface uncovered, and if the colors are then taken off, the fine veins remain, like fine veined marble, on the edges of the book or on the sheet of paper, the spots covered by the water remaining white. A number of spots of different sizes scattered over the entire surface give it the spotted character of an "oil design."

It is evident from the above that the principle of marbling paper is extremely simple, consisting in sprinkling a thin layer of color on a ground of size that will not absorb the colors and then taking the colors off on a smooth surface that has been dipped into them. The art can be practiced by anyone who understands this principle and has learned the peculiar effects of gall and soapy water on the colors. Of course, one who has had experience will do prettier work than a beginner, but a few hours' practice will be worth more than any long-winded explanations. The proper choice of the colors is of the greatest importance, for

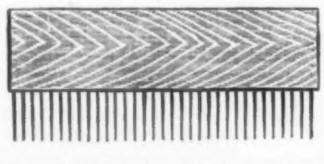


FIG. 1.—COMB FOR COMB DESIGN.

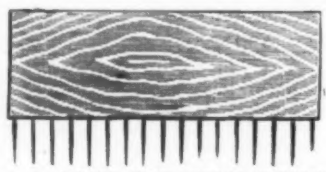


FIG. 2.—COMB FOR COMB DESIGN.

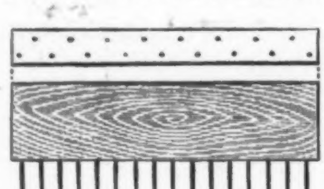


FIG. 3.—COMB FOR FAN OR PEACOCK FEATHER DESIGN.

upon it depends, to a great extent, the success of the work. Only chemically pure colors should be used, and as there are so few that are available, the fact that they are somewhat more expensive should have no weight, because a much larger surface can be covered by a chemically pure color than by one that contains foreign matter. The foreign matter referred to generally consists of barite, which has a tendency to precipitate, making the colors much weaker. Much depends on the lightness of the colors, and in this case, as in many others, the most expensive material is the cheapest in the end. The colors used by the bookbinder are bought either dry—in the form of powder, little cones

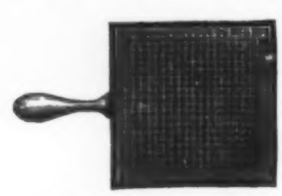


FIG. 4.—SPRINKLING SCREEN.

or in lumps which must be ground—or after they have been ground with water into a paste. Except in very large concerns, where great quantities of colors are used, it is not best to get colors that have already been ground, because they are so liable to dry if not used immediately that the operator would be very likely to find, instead of a paste, a hard lump that would have to be softened with water and then pulverized.

After the colors have been prepared as directed above, each one should be tested so as to see that it meets all requirements. For this purpose a little of the size is poured into the marbling trough after it has been well stirred; then the water that stands on the color should be poured out of the bottle, the color well shaken, and a few drops poured into the vessel intended for this purpose and thinned with a little gall and pure water. One or more drops of the color are now sprinkled on the size by means of a brush formed of soft bristles or rice straw. This is done by striking the brush across the forefinger of the left hand. If the drops do not spread, the color is too thick and a few more drops of gall must be added, as this causes the color to spread or travel. The gall must be added carefully in single drops, for too much gall makes the color pale and causes it to form large and thin drops. The water must be added with equal care. If the colors are too thin, they do not form uniform drops, but spread all over the ground. When the drops measure from one-half to three-quarters of an inch in diameter, sufficient gall has been added.

There is a great diversity of opinion as to the order in which the colors should be sprinkled on. One asserts that the brightest color must be applied first and the darkest last, while another maintains that just the opposite order should be observed. Adam says in regard to this: "The only correct way is to sprinkle on first the color that it is desired to have most intense, for, as it will be driven back most by those that follow, it will thus gain the deepest tone. The last color will have the least depth, and, therefore, it will be best to take yellow, brown or blue last, the latter because it is very intense and powerful even when thinned. In making comb designs, it makes very little difference which color is applied first and which last, but in this case also the peculiarities of the colors must be considered. Black, even when only slightly thinned, will appear grayest, and consequently it should be one of

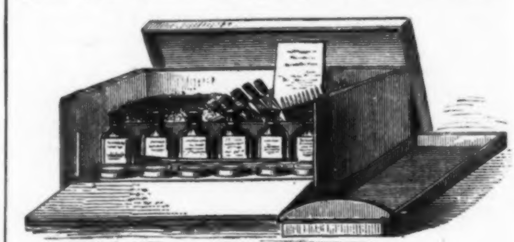


FIG. 5.—WINKLER'S MARBLING OUTFIT.

the first colors sprinkled on the size. Red is recommended as the color which will throw out the design best, while yellow and blue will show it least."

The mineral colors, which were the only ones used formerly, were perfectly dissolved in water and applied with an ordinary brush, and then after the colors were dry they were coated with wax and polished with agate. There was a time when great pains were taken in painting the edges of books. Now aniline colors are used to advantage for painting and sprinkling the edges of books. For the former purpose they are dissolved in pure water, but for the latter in alcohol diluted with water. In both processes saturated solutions must be used.

The utensils used by the bookbinder in marbling are as follows. One or more troughs of zinc or painted iron, a number of long bristle brushes of different sizes, some rice straw brushes (brooms); several combs of different sizes; a number of thin, well planed slats of hard wood beveled on both edges; several sprinkling screens, and patterns. The size of the troughs depends on that of the books. Generally they are about 30 in. long, 10 in. wide and 3 in. deep, so that books of all sizes can be handled in them. They con-

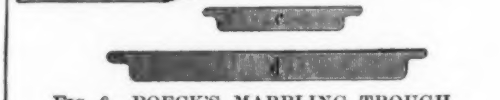


FIG. 6.—BOECK'S MARBLING TROUGH.

tain the gelatinous ground or size on which the operator sprinkles the colors, which are afterward worked by means of combs or styles, as will be described hereafter. The brushes are generally ordinary painters' brushes or socalled lining brushes with long bristles, made to meet the requirements.

In the production of comb, fan and similar designs the socalled comb is used to comb through the colors floating on the size and produce lines which are repeated, following one another in the same direction. The combs (Figs. 1, 2 and 3) consist of a number of needles or pieces of wire glued at intervals of greater or less length between two strips of pasteboard, so that said needles, which resemble the teeth of a comb, project about an inch or an inch and a half beyond the pasteboard. It is of great importance, for the proper combing of the color carpet, that the points of the needles should be in alignment. The distances between the needles, as well as the size of the needles themselves, depend on the nature of the design to be produced. Close, fine lines require fine needles placed close together, about thirty-six needles to each four inches, and for a broad design with heavy lines, the needles must be coarser and be set farther apart; the number of combs

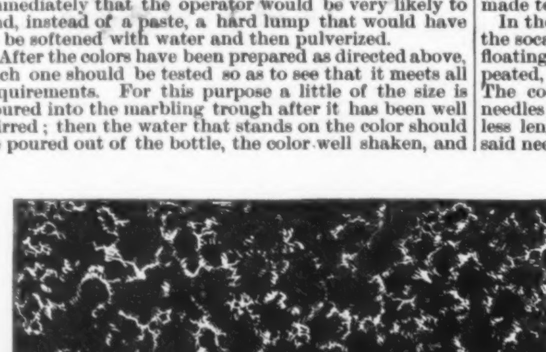


FIG. 7.—CLOUD MARBLE.

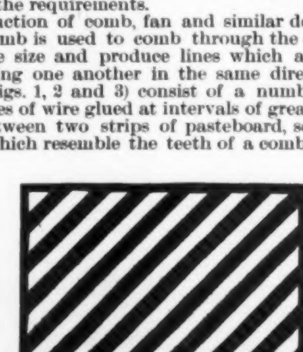


FIG. 8.—PATTERN FOR DIAGONAL DESIGN.

required and their size depends on the nature of the designs to be produced, but half a dozen combs of different sizes will be enough for a large business.

Another sort of comb is required for the production of fan and peacock feather designs. In these there are two rows of needles or teeth so arranged that each tooth of the back row comes between two of the front row. Such a comb produces rounded figures which can be best compared with peacock or argus feathers. In these combs also the sizes of the needles and the

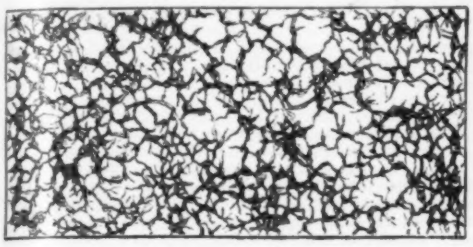


FIG. 9.—FINE-VEINED MARBLE.

spaces between them vary according to the designs to be produced. The combs are made of slats or strips of wood in which holes are bored in the proper positions for the needles.

The sprinkling screen (Fig. 4) consists of a wire frame provided with a handle over which is stretched wire netting with meshes about one-third of an inch in size. The whole device is painted to protect it from rust.

Mr. O. Th. Winkler, of Leipzig, has collected all the utensils needed in marbleizing in a wooden box (Fig. 5), one side of which can be let down so that all the articles will be accessible. The box contains: a trough for the reception of the size; a comb made of long insect pins glued between strips of pasteboard; a strong pin with a wooden handle, or a piece of bone; five glass bottles containing finely ground colors; a bottle of prepared oxgall; five brushes made of bristles for the colors; a rice straw brush for the gall; a bundle of selected carragheen moss; a piece of cloth through which the size can be strained; six little porcelain cups for the colors; strips of wood and paper. This box filled costs $3.75. There is a larger box with more complete outfit that costs $6.25.

Boeck's marbling apparatus (Fig. 6) is made of strong sheet zinc, is about an inch high, and, to prevent

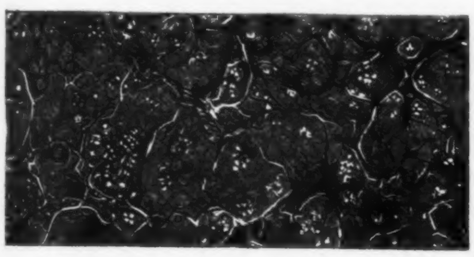


FIG. 10.—FINE-VEINED MARBLE ON A PAINTED GROUND.

oxidation, is painted with oil colors that will not be taken up by the colors used in marbling. It can be separated into three parts. The compartment, a, is intended for the reception of the size on which the colors are sprinkled, and the compartment, b, for the surplus colors, etc., which run off after the book edges or the paper have been dipped into the color carpet. The part, c, is used for scraping off the surplus color or for removing the skin that forms on the top; d is a removable side of the trough which is used for pushing the colors together when they have spread too much.

The socalled fire or cloud marble (Fig. 7) is made as follows: the book to be colored is placed between two boards and the whole put in a press; the cut edges are then scraped, wiped over with water, coated with a thin paste, and after this has been done red or blue coloring matter is applied with the finger to represent flames or clouds, as may be desired, and finally, if cloud effects are being produced, a piece of hard wood provided with little toothlike notches is drawn across so as to make zigzag lines which represent the lightning in the clouds. Cloud effects are also obtained by means of oats or hempseed. These are arranged in various designs along the edges of the book, one or more colors are sprinkled on by means of the sprinkling screen, and after they have dried the seeds are re-

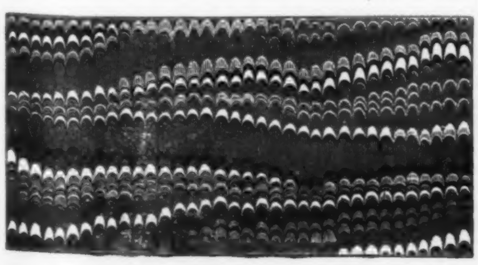


FIG. 11.—FINE COMB DESIGN (FOR BUSINESS BOOKS).

moved. Whole names are sometimes thus formed along the edges of the books, which appear in white after the seeds have been removed; these names, it is true, can often be read only by a practiced eye. Sometimes a sponge is used for sprinkling the edges. All kinds of figures, flowers, etc., may be cut out of paper and fastened on the white edges by means of needles, and when they are removed after the edges have been sprinkled with somewhat darker color, the designs appear in white.

In order to produce the diagonal design (Fig. 8) a piece of cardboard is cut exactly square, all four sides are divided into equal parts, diagonal lines are drawn in pencil, and the strips between these lines are cut out, these strips being made as wide as may be deemed necessary. Instead of plain diagonal lines, wavy lines or lines forming any desired figure may be drawn. While the book is in the frame this cardboard screen is fitted tightly over the edges of the book and the color, for example, blue, is sprinkled on by means of the wire screen. When the cardboard pattern is removed diagonal lines will appear. Now the pattern is turned so that the point, a, will come on the point, b (see Fig. 8), and the stripes will cross. For the second sprinkling red is used, and where the stripes cross squares of two colors are formed, and white stripes remain between those of a single color. By using several colors and shifting the pattern, which must be done very carefully, a network of squares composed of two colors can be formed. This effect can also be obtained with two squares.

In making fine veined marble (Figs. 9 and 10), the ground or size is sprinkled with two colors, first ultramarine blue and then a beautiful dark brown, after which the corner of the trough is tested to see whether the colors float properly. If a pretty uniform color now floats on the size, a short bristle or, better yet, a rice straw brush is dipped into a mixture of gall and water or gall and a thin color, is then shaken so that only a little gall will remain on the brush and this is sprinkled evenly over the color so as to form small drops. The

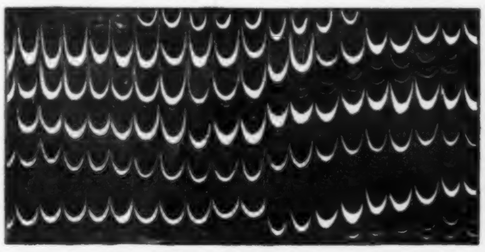


FIG. 12.—COMB DESIGN (FOR BUSINESS BOOKS).

drops of gall will push the colors together, forming narrow veins, and the size will be visible. If very delicate lines are desired, the colors are sprinkled through the sprinkling screen and finally the gall is sprinkled on through another screen.

Fine veined marble is also made as follows: When carragheen moss is used, the size must either be several days old or sufficient borax or soda must be added to it. The colors should be arranged in special bottles, each of which will contain 3½ oz. One is filled with two-thirds parts of blue and another with the same amount of red. One-third part of soft water and twenty-five to thirty drops of gall are added to the brown. A little free space must be left in the bottles, so that the contents can be shaken; the blue is then poured in a little glass, but the red is put in a little open dish. The water for sprinkling consists of one part Venetian soap to four parts of warm water. After the size has been carefully wiped off, a brush is dipped into the blue, stirred around well, shaken slightly, and then tapped over the forefinger of the left hand, so as to cause three or four drops to fall close together on the size; four drops will be sufficient to cover the whole surface. Then the largest rice straw brush, about half as large again as the brush just used, is

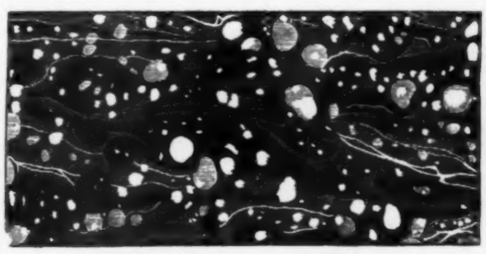


FIG. 13.—OIL DESIGN, ALSO TURKISH MARBLE (FOR BUSINESS BOOKS).

The white places are made by the water sprinkled on the colors.

dipped in the red, stirred around, well shaken against the inside of the dish and then it is struck on a suitable stick or presspin. The strokes of the brush should be from right to left, and short and quick, so as to produce little, thick drops close together. Such drops cannot be obtained with little brushes struck over the forefinger. Water is applied in the same way, but in this case the strokes must be even shorter and quicker, from right to left, but never backward, for that would break the veins. The network of veins will not be as fine as desired at first, but they will gradually draw together. In using gall and water, special care must be taken that the strokes are just right, so that the network shall not be broken, but with soap and water this is not so much to be feared. Nevertheless, some practice is required before the water can be used with just the desired result, for much depends not only on the distance at which the brush and the stick are held from the size or ground, but also on the direction in which the strokes are made. The stick should be held four or five inches from the size and the brush must never be struck too hard, for that will cause the water, and also, to a certain extent, the colors, to be driven into the ground, so that the veins in the finished design will appear shaded and the size will not be clear, for the colors and gall will mix with it, and it will soon be found that colors will not float on such a ground. In sprinkling the water the brush should be held so that the rice straw will extend a little beyond the stick against which the brush is struck, and the strokes should be short and quick to obtain a fine network. The farther the rice straw is allowed to project beyond the stick and the lighter and slower the strokes, the coarser the network will be. If the stick is held lengthwise of the trough and the brush is struck perpendicularly, the veins will be rounded more regularly. If the operator places himself sidewise, so

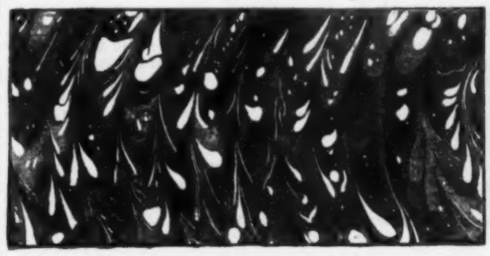


FIG. 14.—OIL COMB DESIGN (BUSINESS BOOKS).

that the stick is in the right corner at the long side of the trough and the brush is held in the same direction, only the middle of the ground will be struck by the water. It will spread toward the long sides of the trough and the veins will become long and fine.

A ground made of gum tragacanth can be used when it is old, even if it is sour, only the water must be made very weak, for the size offers very little resistance to the soap solution. If the network should happen to break, a solution of borax or soda should be added to the size. Soda can be used with greater safety than borax, but it makes the colors pale, so that thicker colors must be used with it. If fine veined marble is made on a moss ground, the edges to be marbled must be moistened, either with alum water or dilute acid. If the acid has no injurious effect on the colors, it is preferable, because after it has been used, the edges can be allowed to dry; but if the alum has been used, the edges must be kept at exactly the right degree of moisture.

If the colors are properly chosen and the work skillfully done the comb designs (Figs. 11 and 12) are superior to all others. In making such designs the colors are first sprinkled on evenly, then the operator takes a

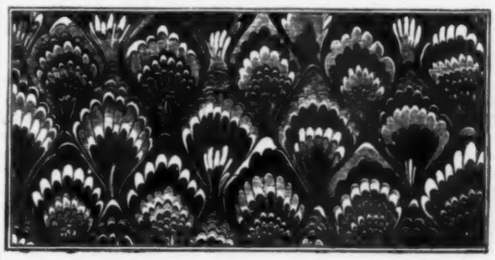


FIG. 15.—FAN DESIGN (BUSINESS BOOKS).

style or pin made for the purpose or a piece of wood or bone, and cuts the drops of color by passing it from one side of the trough to the other, the colors following the pin in straight lines. After this has been done as carefully as possible, the comb is placed in the color at the upper end of the trough and moved across the color lines. By moving the comb slowly round feathers are obtained and by moving it quickly pointed ones are formed. In making comb designs, many recommend sprinkling the drops at the sides and leaving the middle free, because then the lines of color are made by passing the style from one side to the other. Comb designs require a somewhat stronger ground, and they can be made with two, three or more colors. When the color carpet has been properly prepared the stick or style is drawn through it, and the configuration of the colors after they have been combed will depend greatly upon the kind of lines made by the style and the distance between them. The clever marbler will produce a great variety of designs. As much depends, of course, on the form of the comb, that is, the spacing of the teeth, as upon the manipulation of the style or pin. The comb should always be drawn through the color carpet in straight lines, following the side of the trough, whereby the peculiar sickle shaped figures so characteristic of the comb designs will be formed.

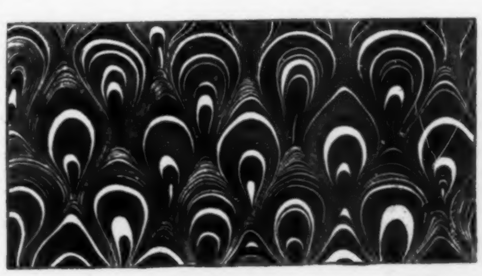


FIG. 16.—FAN DESIGN—PEACOCK FEATHERS (BUSINESS BOOKS).

In producing oil designs (Figs. 13 and 14), the ground should be somewhat thicker than for the fine veined marble designs, because the colors used are thicker and it is necessary to have a carpet that will hold together perfectly. Red is sprinkled on with the brush first, in great drops, which must run over the ground properly, and to this blue, and, finally, yellow are added; the last two colors being applied so that large and small

drops will be scattered irregularly over the red ground. They must not spread much. On this carpet the water is sprinkled in large and small drops, whereby the colors are pushed aside, the drops of water looking like drops of oil on the color carpet. By means of a fine stick the drops of soapy water can be drawn out into veins of different degrees of fineness, which run through the carpet, making very pretty effects.

Comb designs in only two colors; for instance, red and blue, made with a comb in which the teeth are far apart and which is drawn through very irregularly, and sprinkled with drops of soapy water, can be treated like oil designs. They are specially appropriate for very large books.

In making fan designs (Fig. 15) the same work is required as for comb designs, and they are carried out in the same way, the only difference being in the manipulation of the comb. While, as we have seen, the comb designs are made by drawing the comb straight through the color carpet, in fan designs the comb must be drawn in zigzag lines parallel to the long side of the trough. These zigzag lines can consist of straight lines following one another in points or they can be rounded off, so as to make serpentine lines, whereby several effects can be produced.

Generally, for the production of peacock feather marble (Fig. 16) only three colors are used, violet brown, black and yellow; but, of course, every one is free to use other preferred colors, by means of which a brighter effect may be obtained. The colors are sprinkled over one another in drops, as regularly as possible, so that they form circles, at the same time covering the ground with a solid color carpet. No style is drawn through the colors in this case, but after they have been properly distributed a comb with a double row of teeth arranged in straight lines is drawn through, whereby the rings of color are pointed at the bottom, and somewhat rounded at the top, whereby a design is produced which is similar to the design on a peacock feather.—Der Stein der Weisen.

THE MANUFACTURE OF CHLORINE.*

IN endeavoring to fix upon a suitable theme for the address I knew you would to-day expect from me, I have felt that I ought to give due consideration to the interests which tie this magnificent city of Liverpool, whose hospitality we enjoy this week, to Section B of the British Association.

I have therefore chosen to give you a brief history of the manufacture of chlorine, with the progress of which this city and its neighborhood have been very conspicuously and very honorably connected, not only as regards quantity—I believe this neighborhood produces to-day nearly as much chlorine as the rest of the world together—but more particularly by having originated, worked out, and carried into practice several of the most important improvements ever introduced into this manufacture. I was confirmed in my choice by the fact that this manufacture has been influenced and perfected in an extraordinary degree by the rapid assimilation and application of the results of purely scientific investigations, and of new scientific theories, and offers a very remarkable example of the incalculable value to our chemical interests of the progress of pure science.

EARLY HISTORY OF CHLORINE.

The early history of chlorine is particularly interesting, as it played a most important role in the development of chemical theories. There can be no doubt that the Arabian alchemist Geber, who lived 1,100 years ago, must have known that "Aqua Regia," which he prepared by distilling a mixture of salt, niter, and vitriol, gave off, on heating, very corrosive, evil smelling, greenish yellow fumes; and all his followers throughout a thousand years must have been more or less molested by these fumes whenever they used Aqua Regia, the one solvent of the gold they attempted so persistently to produce.

But it was not until 1774 that the great Swedish chemist Scheele succeeded in establishing the character of these fumes. He discovered that on heating manganese with muriatic acid he obtained fumes very similar to those given off by "Aqua Regia," and found that these fumes constituted a permanent gas of yellowish green color, very pungent odor, very corrosive, very irritating to the respiratory organs, and which had the power of destroying organic coloring matters.

According to the views prevalent at the time, Scheele considered that the manganese had removed phlogiston from the muriatic acid, and he consequently called the gas dephlogisticated muriatic acid.

When, during the next decade, Lavoisier successfully attacked, and after a memorable struggle completely upset the phlogiston theory, and laid the foundations of our modern chemistry, Berthollet, the eminent "father" of physical chemistry—the science of to-day—endeavored to determine the place of Scheele's gas in the new theory. Lavoisier was of opinion that all acids, including muriatic acid, contain oxygen. Berthollet found that a solution of Scheele's gas in water, when exposed to the sunlight, gives off oxygen and leaves behind muriatic acid. He considered this as proof that this gas consists of muriatic acid and oxygen and called it oxygenated muriatic acid.

In the year 1787 Berthollet conceived the idea of utilizing the color-destroying powers of this gas for bleaching purposes. He prepared the gas by heating a mixture of salt, manganese and vitriol. He used a solution of the gas in water for bleaching, and subsequently discovered that the product obtained by absorbing the gas in solution of caustic potash possessed great advantages in practice.

This solution was prepared as early as 1789, at the chemical works on the Quai de Javelle, in Paris, and is still made and used there under the name of "Eau de Javelle."

James Watt, whose great mind was not entirely taken up with that greatest of all inventions—his steam engine—by which he has benefited the human race more than any other man, but who also did excellent work in chemistry, became acquainted in Paris with Berthollet's process, and brought it to Scotland. Here it was taken up with that energy characteristic of the Scotch, and a great stride forward was made when, in 1798, Charles Tennant, the founder of the great firm which has only recently lapsed into the United Alkali Company, began to use milk of lime in place of the more costly caustic potash, in making a bleaching liquid; and a still greater advance was made when, in the following year, Tennant proposed to absorb the chlorine by hydrate of lime, and thus to produce a dry substance, since known under the name of bleaching powder, which allowed the bleaching powers of chlorine to be transported to any distance.

THE ART OF BLEACHING IN 1799.

In order to give you a conception of the theoretical ideas prevalent at this time, I will read to you a passage from an interesting treatise on the art of bleaching, published in 1799 by Higgins. In his chapter "On bleaching with the oxygenated muriatic acid, and on the methods of preparing it," he explains the theory of the process as follows:

"Manganese is an oxyd, a metal saturated with oxygen gas. Common salt is composed of muriatic acid and an alkaline salt called soda, the same which barilla affords. Manganese has greater affinity to sulphuric acid than to its oxygen, and the soda of the salt greater affinity to sulphuric acid than to the muriatic acid gas; hence it necessarily follows that these two gases (or, rather, their gravitating matter) must be liberated from their former union in immediate contact with each other; and although they have but a weak affinity to one another, they unite in their nascent state, that is to say, before they individually unite to caloric, and separately assume the gaseous state; for oxygen gas and muriatic acid gas already formed will not unite when mixed, in consequence principally of the distance at which their respective atmospheres of caloric keep their gravitating particles asunder. The compound resulting from these two gases still retains the property of assuming the gaseous state, and is the oxygenated muriatic gas."

Interesting as these views may appear, considering the time they were published, you will notice that the rôle played by the manganese in the process, and the chemical nature of this substance, were not at all understood. The law of multiple proportions had not yet been propounded by John Dalton, and the researches of Berzelius on the oxides of manganese were only published thirteen years later, in 1812. The green gas we are considering was still looked upon as muriatic acid, to which oxygen had been added, in contradistinction to Scheele's view, who considered it as muriatic acid, from which something, viz., phlogiston, had been abstracted.

DAVY'S WORK ON CHLORINE.

It was Humphry Davy who had, by a series of brilliant investigations, carried out in the laboratory of the Royal Institution between 1808 and 1810, accumulated fact upon fact to prove that the gas hitherto called oxygenated muriatic acid did not contain oxygen. He announced in an historic paper, which he read before the Royal Society on July 12, 1810, his conclusion that this gas was an elementary body, which in muriatic acid was combined with hydrogen, and for which he proposed the name "chlorine," derived from the Greek χλωρός, signifying "green," the color by which the gas is distinguished.

The numerous communications which Humphry Davy made to the Royal Society on this subject form one of the brightest and most interesting chapters in the history of chemistry. They have recently been reprinted by the Alembic Society, and I cannot too highly recommend their study to the young students of our science.

Those who have followed the history of chemistry I need not remind how hotly and persistently Davy's views were combated by a number of the most eminent chemists of his time, led by Berzelius himself, how long the chlorine controversy divided the chemical world, how triumphantly Davy emerged from it, how completely his views were recognized, and how very instrumental they have been in advancing theoretical chemistry.

The hope, however, which Davy expressed in that same historic paper, "that these new views would, perhaps, facilitate one of the greatest problems in economical chemistry, the decomposition of the muriates of soda and potash," was not to be realized so soon. Although it had changed its name, chlorine was still for many years manufactured by heating a mixture of salt, manganese and sulphuric acid in leaden stills, as before.

CHLORINE AS A BY-PRODUCT.

This process leaves a residue consisting of sulphate of soda and sulphate of manganese, and for some time attempts were made to recover the sulphate of soda from these residues and to use it for the manufacture of carbonate of soda by the Le Blanc process. On the other hand, the Le Blanc process, which had been discovered and put into practice almost simultaneously with Berthollet's chlorine process, decomposed salt by sulphuric acid, and sent the muriatic acid evolved into the atmosphere, causing a great nuisance to the neighborhood.

Naturally, therefore, when Mr. William Gossage had succeeded in devising a plant for condensing this muriatic acid, the manufacturers of chlorine reverted to the original process of Scheele and heated manganese with the muriatic acid thus obtained. Since then the manufacture of chlorine has become a by-product of the manufacture of soda by the Le Blanc process, and remained so till very recently.

For a great many years the muriatic acid was allowed to act upon native ores of manganese in closed vessels of earthenware or stone, to which heat could be applied either externally or internally. These native manganese ores, containing only a certain amount of peroxide, converted only a certain percentage of muriatic acid employed into free chlorine, the rest combining with the manganese and iron contained in the ore and forming a brown and very acid solution, which it was a great difficulty for the manufacturer to get rid of. Consequently, many attempts were made to regenerate peroxide of manganese from these waste liquors, so as to use it over again in the production of chlorine.

These, however, for a long time remained unsuccessful, because the exact conditions for superoxidizing the protoxide of manganese by means of atmospheric air were not yet known.

DUNLOP'S WORK ON CHLORINE.

Meantime, viz., in 1845, Mr. Dunlop introduced into the works created by his grandfather, Mr. Charles Tennant, at St. Rollox, a new and very interesting method for producing chlorine, which was, in a certain measure, a return to the process used by the alchemists.

Indeed, the first part of this process consisted in decomposing a mixture of salt and niter with oil of vitriol—a reaction that had been made use of for so many centuries! The chlorine so obtained is, however, not pure, but a mixture of chlorine with oxides of nitrogen and hydrochloric acid, which Mr. Dunlop had to find means to eliminate.

For separating the nitrous oxides, Mr. Dunlop adopted the method introduced twenty years before by the great Gay-Lussac in connection with vitriol making, viz., absorption by sulphuric acid, and the nitro-sulphuric acid thus formed he also utilized in the same way as that obtained from the towers which still bear Gay-Lussac's illustrious name, viz., by using it in the vitriol process in lieu of nitric acid. He then freed his chlorine gas from hydrochloric acid by washing with water, and so obtained it pure. This process possessed two distinct advantages: (1) it yielded a very much larger amount of chlorine from the same amount of salt and (2) the nitric acid, which was used for oxidizing the hydrogen in the hydrochloric acid, was not lost, because the oxides of nitrogen to which it was reduced answered the purpose for which the acid itself had previously been employed. But this process was very limited in its application, as it could only be worked to the extent to which nitric acid was used in vitriol making.

The process has been at work at St. Rollox for over fifty years, and, as far as I know, is there still in operation; but I am not aware that it has ever been taken up elsewhere.

Within the last few years, however, several serious attempts have been made to give to this process a wider scope by regenerating nitric acid from the nitro-sulphuric acid and employing it over and over again to convert hydrochloric acid into chlorine. Quite a number of patents have been taken out for this purpose, all employing atmospheric air for reconverting the nitrous oxides into nitric acid and differing mainly in details of apparatus and methods of work, and several of these have been put to practical test on a fairly large scale in this neighborhood, and also in Glasgow, Middlesbrough and elsewhere.

As I do not want to keep you here the whole afternoon, I have to draw the line somewhere as to what I shall include in this brief history of the manufacture of chlorine, and have had to decide to restrict myself to those methods which have actually attained the rank of manufacturing processes on a large scale. As none of the processes just referred to have attained that position, you will excuse me for not entering into further details respecting them.

Mr. Dunlop's process only produced a very small portion of the chlorine manufactured at that time at St. Rollox, the remainder being made, as before, from native manganese and muriatic acid, leaving behind the very offensive waste liquors I have mentioned before, which increased from year to year, and became more and more difficult to get rid of. The problem of recovering from these liquors the manganese in the form of peroxide Mr. Dunlop succeeded in solving in 1855.

He neutralized the free acid and precipitated the iron present by treating these liquors with ground chalk in the cold and settling out, and in later years filter pressing the precipitate, which left him a solution of chloride of manganese mixed only with chloride of calcium. This was treated with a fresh quantity of milk of chalk, but this time under pressure in closed vessels provided with agitators and heated by steam, under which conditions all the manganese was precipitated as carbonate of manganese. This precipitate was filtered off and well drained, and was then passed on iron trays mounted on carriages through long chambers, in which it was exposed to hot air at a temperature of 300° C., the process being practically made continuous, one tray at the one end being taken out of these chambers and a fresh tray being put in at the other end. One passage through these chambers sufficed to convert the carbonate of manganese into peroxide, which was used in place of, and in the same way as, the native manganese.

The whole of the residual liquors made at the large works at St. Rollox have been treated by this process with signal success for a long number of years. For a short time the process was discontinued in favor of the Weldon process (of which I have to speak next), but after two years Dunlop's process was taken up again, and, to the best of my knowledge, it is still in operation to this day. It has, however, just like Mr. Dunlop's first chlorine process, never left the place of its birth (St. Rollox), although it was for a period of over ten years without a rival.

WELDON'S PATENT PROCESS.

In 1866, Mr. Walter Weldon patented a modification of a process proposed by Mr. William Gossage, in 1837, for recovering the manganese that had been used in the manufacture of chlorine. Mr. Gossage had proposed to treat the residual liquors of this manufacture by lime, and to oxidize the resulting protoxide of manganese by bringing it into frequent and intimate contact with atmospheric air. This process—and several modifications thereof subsequently patented—had been tried in various places without success. Mr. Weldon, however, did succeed in obtaining a very satisfactory result, possibly—even probably—because, not being a chemist, he did not add the equivalent quantity of lime to his liquor to precipitate the manganese, but used an excess. However, Mr. Weldon, if he was not a chemist at that time, was a man of genius and of great perseverance. He soon made himself a chemist, and having once got a satisfactory result, he studied every small detail of the reaction with the utmost tenacity until he had thoroughly established how this satisfactory result could be obtained on the largest scale with the greatest regularity and certainty.

He even went further, and added considerably to our theoretical knowledge of the character of manganese peroxide and similar peroxides by putting forward the view that these compounds possess the character of weak acids. He explained in this way the necessity for the presence of an excess of lime or other base if the

* Opening address by Dr. Ludwig Mond, F.R.S, President of the Chemistry Section, British Association for the Advancement of Science, and published in Pharmaceutical Journal.

oxidation of the precipitated protoxide of manganese by means of atmospheric air was to proceed at a sufficiently rapid rate. He pointed out that the product had to be considered as a manganite of calcium, a view which has since been thoroughly proved by the investigations of Goergen and others; and it is only fair to state that Weldon's process is not only a process for recovering the peroxide of manganese originally used, but that he introduced a new substance, viz., manganate of calcium, to be continuously used over and over again in the manufacture of chlorine.

Mr. Weldon had the good fortune that his ideas were taken up with fervency by Colonel Gamble, of St. Helens, and that Colonel Gamble's manager, Mr. F. Bramwell, placed all his experience as a consummate technical chemist and engineer at Mr. Weldon's disposal, and assisted him in carrying his ideas into practice. The result was that a process which many able men had tried in vain to realize for thirty years became in the hands of Mr. Weldon and his coadjutors within a few years one of the greatest successes achieved in manufacturing chemistry.

The Weldon process commences by treating the residual liquor with ground chalk or limestone, thus neutralizing the free acid and precipitating any sulphuric acid and oxide of iron present. The clarified liquor is run into a tall cylindrical vessel, and milk of lime is added in sufficient quantity to precipitate all the manganese in the form of protoxide. An additional quantity of milk of lime, from one-fifth to one-third of the quantity previously used, is then introduced, and air passed through the vessel by means of an air compressor. After a few hours all the manganese is converted into peroxide; the contents of the vessel are then run off; the mud, now everywhere known as "Weldon mud," is settled, and the clear liquor run to waste. The mud is then pumped into large closed stone stills, where it meets with muriatic acid, chlorine is given off, and the residual liquor treated as before.

HOW WELDON'S PROCESS WORKS.

You note that this process works without any manipulation, merely by the circulation of liquids and thick magmas which are moved by pumping machinery. As compared to older processes, it also has the great advantage that it requires very little time for completing the cycle of operations, so that large quantities of chlorine can be produced by a very simple and inexpensive plant. These advantages secured for this process the quite unprecedented success that within a few years it was adopted, with a few isolated exceptions, by every large manufacturer of chlorine in the world; yet it possessed a distinct drawback, viz., that it produced considerably less chlorine from a given quantity of muriatic acid than either native manganese of good quality or Mr. Dunlop's recovered manganese.

At that time, however, muriatic acid was produced as a by-product of the Le Blanc process so largely in excess of what could be utilized that it was generally looked upon as a waste product of no value. Mr. Weldon himself was one of the very few who foresaw that this state of things could not always continue. The ammonia-soda process was casting its shadow before it. Patented in 1838 by Messrs Dyar and Hemming, it was only after the lapse of thirty years (during which a number of manufacturing chemists of the highest standing had in vain endeavored to carry it into practice) that this process was raised to the rank of a manufacturing process through the indomitable perseverance of Mr. Ernest Solvay, of Brussels, and his clear perception of its practical and theoretical intricacies. A few years later, in 1872, Mr. Weldon already gave his attention to the problem of obtaining the chlorine of the salt used in this process in the form of muriatic acid. He proposed to recover the ammonia from the ammonium chloride obtained in this manufacture by magnesia instead of lime, thus obtaining magnesium chloride instead of calcium chloride, and to produce muriatic acid from this magnesium chloride by a process patented by Clemm in 1863, viz., by evaporating the solution, heating the residue in the presence of steam, and condensing the acid vapors given off.

Strange to say, this same method had been patented by Mr. Ernest Solvay within twenty-four hours before Mr. Weldon lodged his specification. It has been frequently tried with many modifications, but has never been found practicable. Soon afterward Mr. Weldon, with the object of reducing the muriatic acid required by his first process, proposed to replace the lime in this process by magnesia, and so to produce a manganite of magnesia. After treating this with muriatic acid, and liberating chlorine, he proceeded to evaporate the residual liquors to dryness, during which operation all the chlorine they contain would be disengaged as hydrochloric acid and collected in condensers, while the dry residue, after being heated to dull redness in the presence of air, would be reconverted into manganite of magnesia.

This process was made the subject of long and extensive experiments at the works of Messrs. Gamble at St. Helens, but did not realize Mr. Weldon' expectations. It, however, led to some further interesting developments, to which I shall refer later on.

(To be continued.)

WEALTH BASED UPON ELASTIC GUM.

THE latest advices from Para, the great rubber mart at the mouth of the Amazon, are that more rubber has arrived there from the interior since July 1, the beginning of the crop season, than in the same period of any preceding year. All records in rubber production in Brazil were broken in 1895, but it would not be surprising if the output should be still greater this season; so that no fear need be entertained of a lack of rubber for bicycle tires, or any of the thousand and one other modern uses for this wonderful gum. It is a singular fact that the yield of rubber from the Amazon valley has increased, almost without exception, in every year since 1839. All this time the work of exploring the tributaries of the Amazon has been going on, opening to navigation the world's greatest system of waterways, and, as every stream in that section is lined with rubber trees, naturally the gathering of gum has increased. There has also been developed a spirit of enterprise which gives promise of continued activity in the rubber trade. A dozen new steamers have been ordered within a year for navigating the Amazon and its branches, their principal purpose being to convey to market the ever growing rubber crop, and to carry on their return trips an equal weight of merchandise obtained in exchange for it. Lately 1,300 miles of telegraph cable have been laid in the Amazon between Para, the seaport, and Manaos, the capital of the neighboring state up the river, and its chief reliance for income is the rubber traffic.

Ninety-eight per cent. of the revenues of the state of Para come from the export duty on rubber, amounting to 21 per cent. of its value. At the present price of fine Para rubber the state collects 15 cents per pound as its share. With the development of the rubber trade, the formerly insignificant village of Para has grown to be a city of 100,000 inhabitants, with several daily newspapers, eight banks, electric lights, street railways, which last year carried 10,000,000 passengers, the finest theater in Brazil, and beautiful parks—all the direct results of the trade in rubber. And Manaos, up the river, the coming rival of Para in the rubber trade, is undergoing a similar transformation, although the population is not yet so large. New York capitalists are now putting up an electric lighting plant in Manaos, and other modern improvements are gaining a foothold in this old Indian village which has become the capital of a state greater in extent than any in Uncle Sam's big family.

Thus it will be seen that rubber is the mainstay and support of the northern Brazilian states, both of the governments and of the population, and the foundation of all municipal and commercial growth and of internal improvements of whatever character. The same thing is true of Bolivia and eastern Peru, whose rubber output is floated down the Amazon to the seaboard, being credited in the end to Para. There would appear to be more reason for the veneration of the rubber tree by the natives of Brazil than by the Abors, on the northern frontier of British India, according to whose mythology their rubber tree is the abode of a great and powerful spirit, whom they seek constantly to conciliate. But while the people who regard the rubber tree as sacred will protect it at the risk of their lives, although it serves them no useful purpose, the Brazilian rubber gatherer has to be restrained by law from recklessly destroying the tree which yields his principal support.

But the countries named are by no means the only parts of the world that are being developed by the rubber traffic. The towns of Accra and Lagos, on the west coast of Africa, are attaining new importance from the same cause. The expected traffic in rubber is one great incentive to the building of the Congo railway, already half completed. The search for rubber is leading to the fuller exploration of Burma. Altogether, rubber is proving a great factor in civilization, being, besides ivory, almost the only commodity produced in the interior of any tropical country that will bear the expense of transportation to the seaboard. Thus it has been in many places the basis of the first commerce and the first transportation systems, opening the way to a diversified and more extensive traffic. Having served this useful purpose, the crude rubber, in the hands of the chemist and the manufacturer, changes into forms which enter into every phase of life and have a bearing upon every branch of human endeavor. Without the rubber tire, we should not have known the bicycle as it now exists, with its far reaching influence on health, manners and morals in every land—for it seems as if the bicycle would come into general use even in places where the wearing of clothes has never become popular. Yet, important as is the use of rubber for tires, probably not more than 4 per cent. of the total consumption of rubber is handled in the bicycle trade. To master the details of all its other uses would be equivalent to a liberal education.

The rubber of Brazil, gathered from trees which are native to no other countries, is so far superior that for many purposes other grades of rubber do not come into competition with it. It is in demand for tires, for insulating electric wires—except for ocean cables, which are covered with gutta percha—for waterproof clothing, the best rubber shoes, medical and surgical goods, erasers, etc., while the African and Asiatic rubbers are available for cheaper foot wear, door mats and some of the mechanical goods, such as hose, belting and packing for steam valves. Strange to say, English speaking people have known this gum for more than a century as India rubber, although the most important supplies have always come from Brazil. The total output from British India from the beginning probably has not exceeded in weight the rubber now floated down the Amazon in a single year.

The following table of the world's production of rubber for 1895, which has not before been published, is compiled, to an important extent, from official sources. Where round numbers are used, they are based upon estimates believed to be too low rather than too high.

	Pounds.
AMERICA.	
Mexico	160,802
Central America	2,000,000
Brazil	46,363,000
Other South America	3,500,000
AFRICA.	
Gold Coast Colony	4,022,385
Lagos	5,060,504
Congo basin	1,406,543
Angola	4,000,000
Portuguese East Africa	500,000
German Africa	1,400,000
Madagascar	1,000,000
Other countries	2,500,000
ASIA.	
Assam and Burma	1,000,000
East Indies	500,000
Total	73,413,234

As rubber has gradually become more valuable, many chemists have attempted to produce artificial rubber, but without success as yet. But manufacturers have learned to extract rubber from worn out goods, so that every cast off rubber shoe or bicycle tire is now readily salable for cash, for the manufacture of what is known as reclaimed rubber. Likewise the fear that the native forests might some time become exhausted has led to numerous projects for the cultivation of rubber.

The British government, alive always to the development of the resources of its colonies, became interested in the subject of establishing plantations of rubber in India, after certain experiments with rubber trees at the royal botanic gardens had given promise of success. The first thing sought was to procure the best varieties from the Amazon valley, for which purpose a commission was given to Clements R. Markham, afterward president of the Royal Geographical Society, whose success earlier in introducing the cultivation of Peruvian bark into Ceylon and India had revolutionized the production of quinine, and led to the abandonment of the cinchona forests in the Andes. Dr. Markham personally visited the South American rubber forests, and with the assistance of eminent British botanists, procured plants and seeds, under circumstances which added to the world's knowledge of rubber bearing species and of the geography of Brazil. The result was less satisfactory than in the case of the cinchona plantations, especially as the interest felt by the government did not survive the long interval required for the Para rubber trees to become productive. There are now, however, in various parts of the Indian empire, groups of the South American rubber trees, including 685 acres of "plantations" on the island of Ceylon, from which a small first lot of gum was gathered last year for export. There has been a revival of interest in rubber in Ceylon, where, by the way, there are no indigenous rubber species of value, and many planters have been buying and planting Para rubber tree seeds, which are now included regularly in the price lists of the local nurserymen.

But the most important outcome of all these experiments is the government plantation of the native rubber trees of India, established in 1873 at Char Duar, near the Brahmaputra River, in northern Assam, and a smaller one at Kulsi, in the same country. From a small beginning these plantations have been increased from time to time until they embrace two thousand acres. The trees first planted are now old enough for tapping, but as yet only a small amount of rubber has been produced, the first care being to produce vigorous trees. Among the many drawbacks to the maintenance of these plantations have been the ravages of wild elephants and deer, the one trampling down and the other feeding upon tender young trees, and also surreptitious tapping by natives more interested in a present pound of rubber than in the future welfare of the trees. The net result of the Indian experiments has been the demonstration that with little labor rubber trees may be grown from planted seeds, and that they will yield as well as native trees. But there are many ways of making money quicker, while the extent of the known rubber forests which remain untouched has prevented most capitalists from giving serious attention to rubber cultivation.

In addition to the maintenance of the Char Duar plantation, the government in India has manifested its interest in rubber by extending its care of the forests in general to rubber in particular, by attempting the enforcement of regulations against cutting down the trees and against the collection of rubber by any method except during certain months. As a feature of the system of regulation, licenses to gather rubber are sold by the government, and all persons other than the licensees are forbidden to go into the forests for rubber. Such regulations, of course, cannot be enforced among the tribesmen inhabiting the Himalayan foothills, beyond the northern boundary of Assam, where the trees are gradually disappearing. But as the product credited to Assam thus shows a falling off, that of Burma increases through fresh discoveries of rubber trees, so that, for a long term of years, the total product of rubber from British India as a whole has scarcely varied one year from another.

Attempts at rubber cultivation on the Western Hemisphere have been more numerous, but more sporadic. Senor Don Matias Romero, who has been so long the Mexican minister at Washington, wearying at one time of public life, retired to his native state of Chiapas and started an extensive plantation of rubber, but his vacation from office holding was brief, and the rubber trees planted by him did not thrive under the succeeding owner. More recently several plantations have come into existence as the result of a subsidy offered by the Mexican government. The largest of these, in the state of Oaxaca, contains 200,000 trees eight years old. An American engineer named Harriman settled in Tehuantepec several years ago and began experimenting with rubber trees for supplying the shade needed in the coffee plantations there, with such success that he has entered extensively into the growth of rubber and coffee together, his work having found imitators as far away as Ceylon. In Costa Rica a Brooklyn man named Minor C. Keith, engaged in railroading, has won two large cash prizes offered by the government to encourage rubber cultivation. In most of the Central American states steps have been taken by the governments, either to protect existing forests from the destruction with which they were once threatened, or to encourage the planting of more trees. The president of Nicaragua recently issued a decree prohibiting the gathering of rubber, save from plantations or privately owned lands, for ten years from January 1, next. In Colombia some small plantations exist, and even in the Brazilian state of Para a law has been passed providing a reward of $546 (paper) for every 2,000 rubber trees planted. But all the plantations growing out of these public measures are of too recent date for any important amount of rubber to have been produced from them.

A recent report from the British foreign office on rubber cultivation in Mexico estimates that the first year's yield from a plantation of 100,000 trees will bring a net profit of $95,000, after deducting the entire cost of the land and all expenses up to the first year of harvesting, while each of the succeeding harvests for twenty-five or thirty years will bring a steady net income of over $100,000. The amount of land required would be 520 acres, and bananas and other crops could be grown between the trees for a few years, the possible profits from which are not taken into account in the above estimate. But people with money to invest are too apt to be deterred by the length of time required for a rubber plantation to be productive to take stock even in a concern promising such heavy profits, although oranges and many other fruits, coffee, tea, etc., do not yield cash returns much more promptly.

A more attractive prospectus can be gotten up for a

company to "exploit" existing rubber forests. At this time an American syndicate is seeking capital to develop a concession covering 10,000,000 acres of land in the Orinoco Valley, one expected source of profits being in the virgin rubber forests known to exist there. The subject of developing the Venezuelan rubber has at times engaged the attention of no less important personages than the Rothschilds, so that it will not be strange if less astute investors contribute funds toward this development. In London papers have been advertised lately the shares of a company with $1,000,000 capital, organized by a Frenchman, operating from New York, to gather rubber in a hitherto unexplored field in French Guiana. So it will be seen that opportunities exist in this trade for the promoter and speculator, as well as for the buyer and seller of rubber as a commodity. It has ever been so since the days of the London Caoutchouc Joint Stock Company, which proposed to extract rubber from the mulberry trees of Assam and apply it to silk spun from cocoons gathered from the same trees, using as a solvent for the gum the naphtha from neighboring wells, the idea being to produce beautiful waterproof stuffs without leaving one's tracks, as it were. There were great days, too, for the rubber promoter immediately following Charles Goodyear's inventions in rubber, when the increased demand for gum led to a rush of prospectors to the Amazon Valley, where they created a "boom" and were ruined by its collapse.

The United States having been from the beginning a larger consumer of rubber than any other country, the question of a home supply of the raw material has often been discussed. But not even during the period when there was a tariff on crude rubber imports did any practical steps toward rubber production take shape. There is, indeed, no reason to believe that the conditions of temperature, moisture, soil, etc., which exist in the home of the best rubber trees—say in the Amazon Valley or in India—are to be found anywhere in the United States. Where the Brazilian rubber tree flourishes, orchids bloom in profusion in the open air, the climate being, in effect, that of the interior of the hot houses in which our florists rear tropical plants. While there have been articles in the Florida newspapers of late about growing rubber trees, it is asserted by one of the best informed men in the trade in New York that there is no probability that such trees would flourish in that State any better than olive trees would on the metal roof of the Tombs prison. Wherever one of the many rubber species is indigenous, the tree may be grown as well from seeds planted by man as from those scattered by the winds, and the product of one will be as rich in its quality of rubber as that of the other, but it requires something more than intense summer heat for brief periods to fit the United States for producing rubber. HAWTHORNE HILL.

[Continued from SUPPLEMENT, No. 1087, page 17379.]

ALTERNATE CURRENT TRANSFORMERS.*

By Dr. J. A. FLEMING, F.R.S.

LECTURE III.—Continued.

THE TESTING OF TRANSFORMERS.

IN considering the performance of transformers, we are not only concerned with the instantaneous efficiency—that is, the efficiency under any particular load—but with what is called the all-day or all year efficiency. This can be calculated when we know the efficiency of the transformer at various loads, and when we know the nature of the load diagram, as it is called, on which the transformer is supplied. Thus, for instance, let us make the assumption that the load diagram of a transformer is a 10 per cent. load diagram—that is to say, let us assume that out of the 24 hours, for 11 hours the transformer is giving no current from the secondary circuit, for 5 hours is supplying at one-tenth of its full secondary output, for 4 hours one-eighth, for 3 hours one-quarter, and for 1 hour three-quarters. It will be found, on adding up these outputs, that they amount to one-tenth of that which the transformer would be supplying if working at its full secondary output for the whole 24 hours. Let us take, then, the case of a 24 hour kilowatt transformer, having 1·35 per cent. loss on open secondary circuit, and 1·35 per cent. to 1·60 per cent. loss at full load. This gives an open circuit loss of 324 watts at no load; that is to say, 324 watts is the bore loss in the transformer at no secondary load; the efficiency at $\frac{1}{10}$ full load is 86 per cent., and at full load 96 per cent. From the total loss diagram it can then be shown that the transformer takes up in its primary circuit 324 watts on open secondary, 2,762 watts at one-tenth of full load, 3,372 watts at one-eighth of full load, 6,420 watts at one-fourth full load, and 18,612 at three-fourths of full load. We can then construct an energy balance sheet for the transformer as follows, putting on one side the energy in watt hours given by the primary circuit, and on the other side the energy in watt hours taken from the secondary circuit, and these figures will be as follows:

ENERGY IN WATT HOURS GIVEN TO PRIMARY CIRCUIT.

11	×	324	=	3,564
5	×	2,762	=	13,810
4	×	3,372	=	13,488
3	×	6,420	=	19,260
1	×	18,612	=	18,612

Total = 68·734 Board of Trade units.

ENERGY IN WATT HOURS TAKEN FROM SECONDARY CIRCUIT.

11	×	0	=	0
5	×	2,400	=	12,000
4	×	3,000	=	12,000
3	×	6,000	=	18,000
1	×	18,000	=	18,000

Total = 60·000 Board of Trade units.

It will be seen therefore that the total Board of Trade units given in the primary circuit in the 24 hours are 68·734, and the total Board of Trade units taken from the secondary circuit in 24 hours are 60·000. The secondary output is, therefore, 87 per cent. of the primary intake, and this is called the all-day efficiency of the transformer on that old diagram. It is not very far from the instantaneous or actual efficiency of the transformer at one-tenth of full load. It will generally be found that the actual efficiency at one-tenth of full load is a very fair guide to the all-day efficiency on a load having a load factor of 10 per cent. One thing that should be noticed in connection with this part of the subject is that the iron core losses in the transformer are diminished as the transformer heats up. The curve in Fig. 42 shows the results of an experiment with a 50

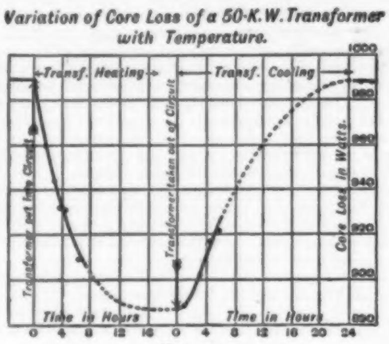


FIG. 42.

kilowatt transformer. The transformer was taken up when perfectly cold, and its core loss was measured and found to be 983 watts. This transformer was then connected with the circuits, and the core loss was taken at various intervals during a period of 20 hours until the transformer had reached a final constant temperature. It was then found that the iron core loss had fallen to 893 watts. The transformer was then disconnected from the circuit and allowed to cool, observations being taken during that period. After 24 hours the transformer had again become quite cold, and the core loss had risen up to 983 watts. There is, therefore, a difference of 100 watts, or nearly ten per cent. in the core loss of the transformer when taken hot and when taken cold. This experiment shows the necessity for defining the conditions under which the core loss and efficiency of a transformer shall be taken; it is not enough to specify simply that the efficiency shall be of a certain value. It must be specified under what conditions this efficiency is to be taken, whether with the transformer cold or the transformer warm.

In addition to this, there is a variation of the iron core loss taking place with time. When a new transformer, which has never before been used, is connected with the circuits, it is often found that when core loss measurements are made continuously at regular intervals, the core loss goes on increasing, and this may take place to the extent of 40, 50, or even 100 or more per cent. increase. In fact, instances have been noticed in which a core loss has increased in the course of a few months to three times its original value. Mr. Mordey found that he could produce this effect in iron by slow heating. It does not occur in all transformers. In an experiment I specially tried with two new Thomson-Houston 30 kilowatt transformers, which were connected to the circuits night and day for three months, and regularly measured at intervals, no apparent increase in the core loss was found. The reasons for this permanent increase in the hysteresis loss are not yet entirely explained. In the case of some iron which has been very carefully annealed, it is found there is a remarkable rise in the hysteresis loss when this iron was used as the core of a transformer. The same rise is also found in the case of iron which has not been very carefully annealed. We cannot at the present moment state precisely what are the conditions under which this increase in core loss takes place, or what is the constituent in the iron that tends to produce it. It has been supposed by some investigators that the presence of silicon in the iron has a tendency to determine this increase in the hysteresis loss, as the iron is magnetically used. It, however, points to the necessity, not only of testing transformers at first, when they are purchased, and before accepting, but of taking a series of tests of the transformer at regular intervals. Suppose that in a substation there are three or four large transformers, and that one of these transformers is made the master transformer, and is kept connected with the circuits night and day, the others only being switched on during the time of heavy demand; then it is obviously a very important matter that the transformer, which is thus made the master transformer, should be the one which has the least core loss; and if it should happen

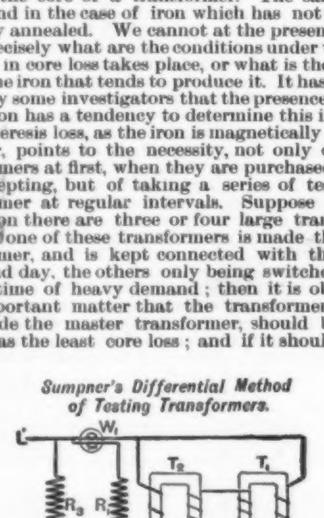


FIG. 43.

that this transformer is one which has largely increased its core loss by use, then it should be exchanged for another which has the least obtainable core loss for that size of transformer. In every substation the wattmeter arrangement described at the beginning of this lecture should be capable of being set up in order to make core loss measurements in a systematic manner. It is perfectly clear that if a few thousand Board of Trade units more than necessary are being wasted in each transformer substation, that the total value of these Board of Trade units when added up and capitalized may realize a very considerable sum of money.

For the purpose of testing large transformers in workshops without requiring a large consumption of power, Dr. Sumpner has devised a differential method of testing, the arrangements of which are shown in the diagram in Fig. 43. In this case the power given out by one transformer on the secondary side is put back into the primary circuit by means of another reverse transformer, so that what is actually taken from the primary mains is merely the total loss in the two transformers. This total loss is measured by a wattmeter arrangement, which enables us to measure, therefore, the efficiency of the two transformers taken together, and, therefore, if they are identical, the efficiency of either of them. In addition to the efficiency tests, there ought always to be a series of security tests to test the strength of the transformer.

In the first place, the temperature should be taken after the transformer has been connected to the mains for twenty-four hours on open circuit and then connected to the mains for two hours on full secondary load. This temperature is best taken, as described in the beginning of the lecture, by measuring the resistance of the copper circuits, but it may be checked by means of a thermometer placed inside the case. Under no circumstances should the temperature in the interior of the transformer rise above 100° C. In the next place, electric pressure equal to double the primary pressure ought to be put on between the primary and the secondary circuits for at least fifteen minutes, and the same double pressure ought to be put on between the primary and case—that is to say, if the transformer works at 2,000 volts on the primary circuit, 4,000 volts should be put on between the primary and secondary circuit for fifteen minutes, and 4,000 volts between the primary and case for fifteen minutes.

In addition to this, the transformer should be tested for several hours at the normal pressure before being put to work. In the case of large transformers which have stood idle for some time, it is not wise to put on the full primary pressure at once. The transformer should be gradually warmed up by passing a large current through the secondary circuit of the transformer, the primary circuit being short circuited. In that manner the transformer will be gradually heated up, any moisture which has been absorbed into the insulating material or into the case will be got rid of, and the transformer will be gradually brought into a condition of high insulation. Transformers which have been standing in the stores for a long time may frequently fail if put suddenly on to the working circuits without some such precaution.

Next, with regard to magnetic leakage, it is important to employ some test to ascertain whether there is a large magnetic leakage. Magnetic leakage, as already explained, is due to an escape of induction, linked with the primary circuit, and which does not entirely pass through the secondary. It is promoted by any separation of the primary and secondary coils, as in Fig. 44,

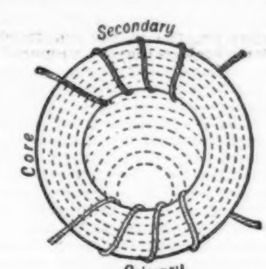


FIG. 44.

but is not entirely eliminated by any arrangement of them, as may be seen by considering the diagrams in Fig. 45. This leakage, of course, can be ascertained by

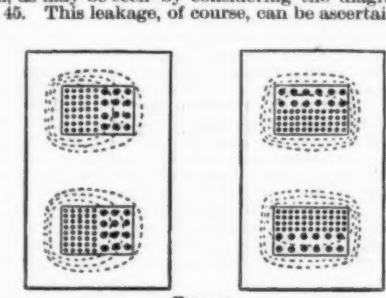
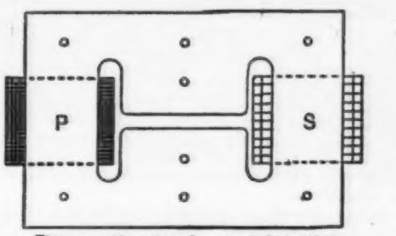


FIG. 45.

measuring the secondary drop as described above and comparing that value with the total copper drop as calculated by the rule already given. An experimental proof of magnetic leakage can be obtained by a simple method due to Mr. Mordey. Two thermometers are taken, one filled with mercury and the other filled with alcohol. These thermometers are compared to see that they are in agreement at the ordinary temperature. The bulbs of the thermometers are then introduced into any portion of the transformer near the secondary coils and kept there for some time. If there is any leakage of magnetic induction outside the secondary circuit, this induction, passing through the mercury thermometer, will generate heat in the mercury and cause the mercury thermometer to rise, but the spirit thermometer will be unaffected by this process. Hence, although both thermometers will rise from external temperature, if the mercury thermometer rises more than the spirit thermometer it indicates the presence of magnetic leakage at that spot where the bulbs are placed. In some transformers magnetic leakage is actually encouraged. A transformer, designed by Elihu Thomson, intended to give constant currents from the secondary circuit when the primary circuit is worked off a constant potential circuit, is constructed as shown in Fig. 46. In this case there is a kind of iron bridge, interrupted by an air gap across the core between the primary and secondary circuit; and across this bridge or air gap in-

* Lecture before the Society of Arts.—From the Journal of the Society.

duction is forced as the secondary current increases. This leakage, therefore, diminishes the electromotive force in the secondary circuit, and that effect tends to keep down the secondary current, and hence, to preserve it at a constant value. Such a transformer can, therefore, be employed to work arc lamps in series of a constant potential primary circuit. The secondary drop is found to be affected to some degree by the nature of the alternators on which the test was made. A peaked primary E.M.F. curve gives a greater leakage



Thomson-Houston, Constant Potential to Constant Current, Transformer.

FIG. 46.

drop than one with a more rounded form. In general, however, magnetic leakage is a thing to be discouraged, and every specification for transformers ought to contain a clause defining and limiting the amount of secondary drop. One convenient way of doing this is as follows:

Suppose the standard secondary electromotive force to be 100 volts and the primary electromotive force 2,000 volts, then the specification should define that when the transformer is working on a constant potential primary circuit of 2,000 volts, the secondary terminal potential difference on the transformer should be 100 volts at half load. At full load the secondary potential difference should not be less than 98½ volts, and at no load should not be greater than 101½ volts. In this manner the unavoidable secondary drop is, as it were, distributed half up and half down, and is not so much felt on the lamps as if the transformer gave its standard electromotive force at no load and then experienced the full effect of the drop when loaded up to full load. Also in a specification for transformers the manufacturer ought never to be allowed to produce a high efficiency at the expense of a large secondary drop, but such a definition of the core loss and copper loss ought to be given that he is bound to produce an all round excellence.

As a sort of guide to the kind of figures which may be obtained by good makers in actual practice, the following table may be taken as representing the secondary drop and core loss in transformers of these various sizes. These figures may be taken as a kind of indication of the core loss and secondary drop which can be obtained in good modern practice in the construction of transformers. Some makers may be prepared to do better than this; but exceedingly small iron core losses ought always to be looked upon with a certain amount of suspicion, the important question being, not how low can the iron losses be made, at first, but how long will they keep low when the transformer is being used; and this, as above stated, can only be determined by careful tests, made at intervals, as the transformer ages.

Size of transformer defined by full secondary output in watts.	Allowable iron core loss on open secondary circuit in watts.	Allowable secondary drop in per cent. of normal secondary electromotive force.
750	20 to 23	3
1,500	36 „ 41	3
2,250	43 „ 50	3
3,000	49 „ 57	3
3,750	62 „ 71	3
4,500	65 „ 74	2¾
6,000	75 „ 87	2
7,500	88 „ 101	2
9,000	105 „ 121	2
10,500	115 „ 133	2
12,000	121 „ 139	2
13,500	138 „ 155	2
15,000	150 „ 172	2

A SHORT METHOD OF DETERMINING CARBON IN STEEL.

IN a recent number of Dingler's Polytechnisches Journal Dr. Weeren states that Herr Peipers, of Remscheid, has introduced a method of determining carbon in steel which is similar in principle to the assay by touch in use for gold. A series of test bars of known carbon contents, and varying from each other by about 0·2 per cent. between the limits of 0·2 per cent. and 1·2 per cent., form the touch needles, while the touch stone is represented by a slab of porcelain. The bar is hammered and filed to a blunt conical point, which leaves a black mark when rubbed on the porcelain slab. The sample to be examined is rubbed upon the center of the plate to form a patch of about the breadth and length of the finger, a similar one being made on either side of it with two of the bars whose composition is known. The chief point to be attended to is to make the patches uniform in depth of tint, which can be readily done with a little practice. The marked slab is then immersed to about half its depth in a beaker containing a 12½ per cent. solution of copper-ammonium chloride in water, which dissolves away the iron from the immersed portions of the patches, leaving the carbon behind as a gray stain, whose intensity increases with the percentage proportion. Steel with about 1½ per cent. of carbon is nearly as dark after as before immersion, while that with 0·25 per cent. gives only a very pale shade when the iron is removed. If the metal were perfectly free from carbon, the mark would be completely dissolved. Numerous substances have been tried for streak-plates, including agate, Arkansas stone, hard glass, and feldspar, but none of them have been found equal to unglazed porcelain. In its ordinary state, however, the latter is too rough to abrade the metal equally, so that it must be rubbed down with coarse emery cloth to render the surface sufficiently uniform. The markings may be nearly completely removed by washing in water, but a more satisfactory method is to clean the slab by immersion for fifteen minutes in nitric or hydrochloric acid, which removes rust spots and stains, and restores the original white surface. The method is capable of indicating differences of 0·05 or 0·025 per cent. of carbon under favorable conditions.

SOME ELECTRIC MOTORS AT THE NUREMBERG EXPOSITION.

WE publish herewith engravings, for which we are indebted to Uhland's Wochenschrift, of two interesting motors exhibited at the Nuremberg Exposition by Johann Weiss, of Landshut. This firm has been endeavoring to facilitate the practical use of electricity, and has constructed an electric motor by means of

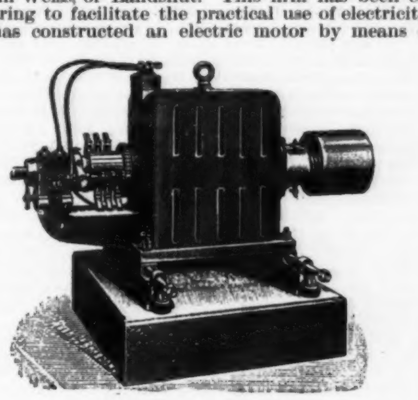


FIG. 1.

which the power can be transmitted directly to different machines without the use of any intermediate wheel work. This motor (Fig. 1) is mounted on a special base, so that, by the aid of intermediate gearing, the great number of revolutions made by the armature per minute can be reduced to suit normal conditions; that is, to about 200 revolutions. For this purpose a countershaft is journaled on the base. A bracket is secured on the side of the base which forms a support for a fixed resistance operated by a convenient vertical lever, which facilitates the starting of the motor. The conductors are so connected that any disturbance of the circuit can be quickly discovered and remedied. The driving wheels are provided with suitable shields so as to meet the requirements of the accident insurance regulations. The above firm has made a special effort to apply electrical energy to the driving of agricultural machines and has mounted one of its motors on a truck (Fig. 2), so that farmers can use it in any desired locality. This motor develops six to twelve h. p., and can be used advantageously for driving thrashing machines, feed cutters, circular saws, etc. For protection from the weather the motors are provided with revolving casings. Each truck is provided with a drum carrying two rolls of insulated cable, each roll containing about 330 feet, which can be connected to the dynamo circuit by a simple device. The starting resistance is inclosed in the same casing with the motor, so that the latter can be easily set in operation anywhere. All the motors are provided with carbon brushes. The works of Johann Weiss are also represented at the Exposition by numerous other electrical motors and dynamos.

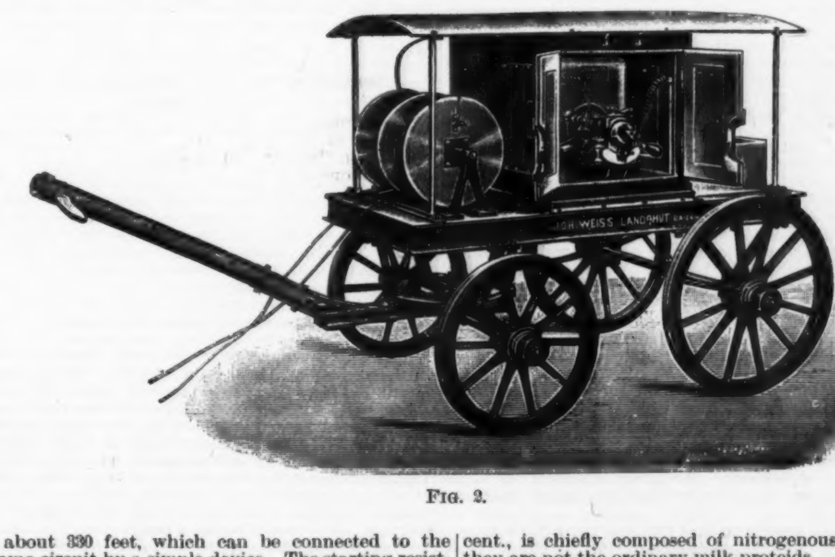


FIG. 2.

M. K. OLSZEWSKI has found that helium cannot be liquefied by the most powerful methods yet available. It is more permanent than hydrogen, probably owing to its monatomic structure, and is on that account valuable as a thermometric substance at very low temperatures. A comparison of a helium and a hydrogen thermometer shows, however, that hydrogen has normal expansion as far as —234·5° Cent., its critical temperature, and is therefore available for thermometric use down to that point.

RECENT ADVANCES IN MILK INVESTIGATIONS.*

By H. W. WILEY.

IT is, perhaps, a matter of astonishment to have printed the title of a paper on a subject which has been so thoroughly investigated as the composition of milk. After all, however, the peddler is not always at fault who "carries coals to Newcastle," and, therefore, with some degree of trepidation, I venture to bring forward this subject in a locality where so much has been done in the study of the composition of milk.

The bacterial theory of milk decomposition has, of late years, obtained complete sway, and we have come to regard milk more as a nutrient fluid for innumerable billions of micro-organisms, at least from a scientific point of view, than as a nutrient for man. It must be admitted, I think, by everyone that on this side of the water we have taken the lead in those studies which have revealed so clearly the character and influence of the action of micro-organisms in milk. To Prof. Conn, who has taken the lead in these investigations, the dairy industry owes a great debt of gratitude.

I suppose there is scarcely any well-informed chemist, at the present time, who does not fully, or at least in a great measure, indorse the theory of milk changing which Prof. Conn has developed with so much ingenuity, industry and skill. In the few moments I shall consume in the presentation of this paper it would be an unnecessary use of time to even give a resumé of Prof. Conn's researches. I will therefore confine myself to a brief statement of some of the less known investigations, at least on this side of the water, which have recently been made.

Investigations of the composition of milk naturally arrange themselves into several classes. The most vitally important, in so far as the welfare of the human race is concerned, are those investigations which determine the composition of milk as a nutrient.

From an economic point of view, the study of normal milk in respect of its content of fat and other food constituents is of paramount interest.

From the purely chemical point of view, perhaps the most important studies are those which relate to the composition of the different proteid bodies contained in the milk and the changes which they undergo, spontaneously or under the influence of bacterial life.

In respect of the first class of investigations, it may be said that the most important, of late, have been those which relate to the composition of human milk and the attempts to imitate it in furnishing artificial beverages for infants. The most important work which has been done of late years in this line is that of Dr. Soldner. (Zeit. fur Biologie, vol. 33, s. 43.)

The most interesting deduction which is drawn from the work of Soldner is in respect of the proteid content of woman's milk. Instead of a proteid content of 2·5 per cent., as is usually given in analyses, it was found that the average content of a large number of samples, in proteid matter, was scarcely 1·5 per cent., while, in a great many instances, the content fell to less than 1 per cent. There was a corresponding increase in the percentage of milk sugar, the average being considerably above 6 per cent. The content of fat, on the other hand, is distinctly less than that of cow's milk and the content of ash only about one-third as great. The following is the average composition of woman's milk, as determined from the analysis as given by Soldner:

Proteids	1·52	per cent.
Fat	3·28	"
Sugar	6·50	"
Ash	0·27	"
Citric acid	0·05	"
Undetermined	0·78	"
Total dry substance	12·40	"

The unknown so-called extract matter, viz., 0·78 per cent., is chiefly composed of nitrogenous bodies, but they are not the ordinary milk proteids.

When it is taken into consideration that an infant four weeks old consumes on an average 580 cubic centimeters of milk in 24 hours, it is seen that from 2·5 to 3·5 grammes of this unknown nitrogenous matter is taken into the stomach daily.

This material is not so abundant in cow's milk, and it is, therefore, at once evident that cow's milk, however it may be diluted or altered, can never completely supply the natural nutriment of the infant.

It is certain that the nitrogenous decomposition products of proteid matter which are found in blood are found uniformly in the milk.

Among these decomposition products the chief are urea, hypoxanthin, kreatinin, sulfocyanic acid and lecithin. These bodies are present in extremely minute

* Read before the New York Section of the American Chemical Society.

quantities, and, while they must be considered as natural constituents of the milk, they cannot be regarded as hygienic constituents thereof.

It is evident, from this brief resumé, that our common ideas concerning the composition of woman's milk are erroneous and that the analytical processes which calculate as proteid matter the total nitrogen of a sample of milk, multiplied by an arbitrary factor, are unreliable.

Soldner calculates the proteid matter in milk by the method of Munk. In this method, that part of the nitrogen is regarded as extract nitrogen, that is, not proteid matter, which is not precipitated by the action of tannic acid in the presence of common salt. In woman's milk, this extract nitrogen amounts to about 9 per cent. of the total nitrogen present and in cow's milk about 6 per cent.

It is evident that the method of precipitating the proteid matter with tannic acid in the presence of common salt may leave in solution not only the so-called extract nitrogen, but also some globulin. It is probable, therefore, that the whole of the nitrogen which is reckoned as extract matter may not be composed of the decomposition products mentioned.

On the other hand, it is quite possible that some of the extract nitrogen may be precipitated with the proteid matters in the circumstances mentioned.

These observations, however, are of the greatest interest, from a hygienic and physiological point of view, and especially in connection with the problem of the nutrition of infants.

Mention has been made above of the commonly accepted theory that the alterations of milk are due to the action of bacteria which are not normal constituents thereof. According to the researches of Béchamp which have lately been published (Bulletin de la Société de Chimique de Paris, series 3, tome 15, page 453) this view is not correct.

According to Béchamp, the milk derived from healthy animals is capable of spontaneous alteration, which consists in the development of lactic acid and alcohol and the development of curd in those milks which contain caseinates produced by the precipitating action of the acids formed. Oxygen and the germs which are present in the air have, according to his view, nothing whatever to do with this alteration of the properties of milk. Milk belongs to that class of organic bodies, like blood, which are called organic from a physiological point of view on account of containing automatic forces which produce rapid changes therein when they are withdrawn from the living organism.

After or before milk has become sour, by the spontaneous action of the microzymes which it contains, there are developed micro-organisms, such as vibriones and bacteria, from a natural evolution from the microzymes.

Milk which is sterilized at a high temperature, viz., that of boiling water or above, is no longer milk in the true physiological sense of that term. The globules of the milk undergo changes and the microzymes a modification of their functions, so that in milk thus altered by heat they are able to produce a coagulation without development of acidity. The microzymes thus modified, however, retain to a large extent their ability to develop into bacteria. Woman's milk differs from cow's milk in containing neither caseinates nor casein, but special proteid bodies and also a galactozyme or galactozymase functionally very different from that which exists in cow's milk. The extractive matter is also a special kind consisting of milk globules and microzymes belonging particularly to it and containing three times less phosphate and mineral salts than cow's milk. Boiling the milk of the cow and other animals does not render it similar to that of woman. There is no treatment, therefore, of any milk which renders it entirely suited to the nourishment of infants. The composition of the milk of the cow may be represented by three groups:

1. Organic elements in suspension, consisting chiefly of the globules of the milk which are mostly composed of the fat, or an epidermoid membrane containing mineral matter of special soluble albumens, and of microzymes containing also mineral matter.

2. Dissolved constituents, consisting of caseinates, lactalbuminates and galactozymase holding phosphates in combination, lactose, extractive matter, organic phosphates of lime, acetates, urea and alcohol.

3. Mineral matters in solution, consisting of sodium and calcium chlorides, carbon dioxide and oxygen.

It will be noticed from the above classification that Béchamp fails to mention citrate of lime as one of the constituents of cows' milk.

It is not possible for me, at the present time, to give any definite opinion in regard to the weight which should be attached to Béchamp's conclusions. His views of the spontaneous alterability of milk appear to be a resumé of old theories, and they are not shared by modern authorities. I have myself repeatedly observed one phenomenon which he mentions, viz., that boiled milk will become curdled without showing the least degree of acidity, and I have often been struck with wonder at the statements which have been made in regard to the almost incredible number of bacteria found in milk immediately when it is withdrawn from the udder.

The somewhat surprising results of the investigations of Soldner and Béchamp are quite sufficient to incite the investigators to a new series of studies of bacterial action in milk.

If it should prove true that milk contains the autogenetic germs for its own change, and that by the development of these germs into vibriones and bacteria, the natural souring of milk takes place, it will be necessary to change completely the common view respecting these processes. The weight of evidence now is against the truth of this theory.

In regard to the economic aspect of milk investigations, I think it is possible to report a considerable degree of progress. It is certain now that the value of milk, both for butter making and cheese making, should be gaged by its content of butter fat. The investigations which have been carried on in the agricultural experiment stations of Wisconsin and New York have, I think, settled beyond all cavil the fact that milk should be paid for, both for butter and cheese making, by its content of fat.

The question then is presented with renewed interest regarding the legal minimum content of fat in full milk. With a view of further investigating this point, we have lately undertaken the examination of milk from individual cows from a large herd near Washington. It is claimed by many dealers that any milk from a healthy cow should be sold without legal restriction, no difference what its content of fat may be. This contention I do not believe justifiable, since the value of milk for domestic purposes is based largely, as in the case of butter and cheese making, on its content of fat. I have long been convinced that a minimum of 3 per cent. of fat is quite low enough as a standard for whole milk. If the milk of a herd should show a less content of fat than 3 per cent., it is due either to fractional milking, leaving the strippings to be sold for cream, or else to the admixture of a large number of cows giving a milk very poor in fat.

The data which we have obtained from the examination of individual samples from 75 cows show an average content of 3·65 per cent. of fat, with a variation of from 2·1 to 6·3 per cent.

Of the total number of samples, viz., 75, from the different cows in this herd, only 12 fell below 3 per cent. of fat. Of these 12 samples, 7 were the product of Holstein cows, 1 of Holstein-Alderney, and 4 Durhams. These data bear out the fact which has been so often observed in respect of the low content of fat in milk of Holstein and Durham cows. Dairymen who propose furnishing milk for consumption, based on the content of fat, should be careful about the purchase of cows of the breeds mentioned, even if they are larger milkers.

At the present time, when the determination of fat in milk is accomplished so quickly and easily, there is little excuse for a dairyman stocking his herd with cows giving milk deficient in fat. The institution of a careful control of the milk sold in cities will be a sufficient impetus, sooner or later, to secure from dairymen the proper control of their herds, not only in respect of the health of the animals, but also as regards the quantity of fat contained in their milk. Dairymen furnishing milk to Washington markets are required to secure certificates from the health office, which are given after the inspection of their herds by a competent veterinarian. The milk sold is also controlled from time to time by a chemist of the health office, and several prosecutions have been successfully instituted against dealers selling milk the fat content of which fell below the standard of 3 per cent.

Personally, I should be in favor of placing the standard of fat in milk higher than 3 per cent., because I believe there is scarcely a herd of well kept cows in the United States which will not furnish a mixed milk of at least 3·5 per cent. of fat.

If this be the normal average for the milk of good healthy herds, there is no reason why the minimum of fat in milk should not be placed at a higher figure than 3 per cent.

There is no use denying the fact that the milk offered for sale in a city will be as close to the minimum standard of fat as possible. There is no good business reason why a dairyman, whose cows give milk which will average 4 per cent. of fat, should sell it in a market where the minimum standard is 3 per cent. Such a dairyman will practice partial milking, selling the last of the milkings for cream, and still supply a milk which would comply with every condition imposed by law.

I am quite aware that this doctrine will not be popular among milk dealers and dairymen, but the rights of the consumer should be considered and respected as well as those of the producer. In advocating a standard of this kind, I am not arguing for a limit which would be difficult of attainment. There would be no difficulty in selecting cows for a dairy by reason of the character of the milk which they give. While it is true that the same cow may, at different times, give a milk of different composition, it is evident that a test, continued for a sufficient length of time, would indicate in general the character of the milk of each individual. By this method of selection the animals giving the milk poor in fat could be separated from the others and fitted for the beef market, while those that give the richer milk could be retained for dairy purposes.

BORINGS AND TURNINGS IN THE FOUNDRY.

A FOUNDRYMAN, referring to the annual accumulation in his machine shop of many tons of cast borings and Bessemer steel and wrought iron turnings, which are sold at a comparatively low price, asks whether there is any method by which these can be utilized in the foundry. The heat of the cupola is too great and the blast too strong for consumption there in unaltered form. The Machinery Moulder's Journal, in answering the question, makes the following suggestions: "If the steel and cast iron turnings are kept separate from the wrought iron, and if the accumulation is not too great, these turnings and borings may be melted in the ladle with the aid of good hot iron, and poured into castings which do not require to be finished. Put from 50 lb. to 80 lb. of steel and cast iron turnings into a large sized shank ladle, and tap good hot iron into it. It is a common practice in many foundries to utilize steel turnings in this way where an extra strong casting is desired; the addition of a small percentage of ferro-aluminum might prove of great advantage in hastening the melting and ridding the metal of impurities. Wrought iron turnings might also be utilized to advantage in the same manner by the addition of a small percentage of aluminum. In the melting of wrought iron it is necessary to heat it to a much higher temperature than is usually obtained in the cupola in order to reach the fluidity necessary to secure a clean, sharp casting, and the resultant castings are of very inferior quality. There is, however, the process of making wrought iron castings known as the 'Mitis' process. The method of making 'Mitis' castings is substantially as follows: The charge of wrought iron is heated to a temperature of 2200° C., at which heat it assumes a pasty condition, when from 0·03 to 0·05 per cent. of aluminum is introduced, in the shape of ferro-aluminum (6 per cent. aluminum). The metal at once becomes fluid, and will produce good, sharp castings, retaining all of the characteristics of wrought iron except the fiber. Cast iron and steel borings and turnings may be melted in the cupola, in the proportion of 10 per cent. to 15 per cent. with high silicon pig, and will make good, strong castings, but it would not be advisable to attempt to melt wrought iron turnings in the cupola."

SELECTED FORMULÆ.

Perfumed Fumigating Papers.—The paper to be used, whatever the perfume afterward employed may be, is first converted into "touch paper" by immersing it in a cold saturated solution of potassium nitrate, and drying on strings. Unsized paper, such as ordinary filter paper, should be used. It is perfumed by dipping into any of the following essences and again drying: Papier d'Armenie.—No. 1. Musk, 10; otto of rose, 1; benzoin, 100; myrrh, 12; powdered orris root, 250; strong spirit of wine (64 per cent.), 300 parts by weight. No. 2. Benzoin, 80; balsam of tolu, 20; storax, 20; yellow santal wood, 20; myrrh, 10; cascarilla, 20; musk, 1; alcohol (64 per cent.), 200 parts by weight. Papier d'Orient.—No. 1. Oil of cloves, 30; oil of cinnamon, 36; oil of bergamot, 48; oil of lavender, 48; simple tincture of benzoin, 420 parts, by weight. No. 2. Balsam of Peru, 15; oil of cloves, 30; oil of bergamot, 30; acetic ether, 36; essence of musk, 6; essence of vanilla, 60; tincture of benzoin, 160; tincture of cedarwood, 30. Other aromatic combinations may be made on similar lines.

Mother of Pearl Imitation.—Imitation of mother of pearl for inlaid work is obtained by varnishing smooth surfaces of paper, cardboard, leather, bone, celluloid, etc. When dry, the surface is daubed with colored bronze powder and is subjected to pressure by means of a die having the desired design upon its face, the die being heated to 105°–150° F. This method is cheap, and the results are durable and can be varied almost indefinitely. Practical working details are missing, however.—Uhland's Wochenschrift.

For Bleaching Yellow Ivory.—The Pharmaceutische Zeitung recommends four different methods, which are worth quoting:

1. Expose the ivory for three or four days to the action of sunlight, in a bath of turpentine oil.

2. Treat it alternately with a solution of potassium permanganate (1 : 250) and oxalic acid (1 : 100), letting the ivory remain in each solution for a half hour; then rinse well with water, and repeat the process a number of times.

3. Place the ivory in a hot mixture of unslaked lime, bran, and water; remove after a very short interval, place in dry sawdust, and with the latter rub thoroughly; then expose to the air.

4. Place in very dilute sulphuric acid or in a solution of lime chloride, then wash off; this is claimed to restore the white color.

Flash Light Powder.—Ommeganch at the Belgian Photographic Society showed an improved flash light powder, prepared by rubbing together in a mortar five parts of magnesium powder, three parts of aluminum powder, and one part of red or amorphous phosphorus. This powder it is claimed is more rapid than either magnesium or aluminum, while free from the danger attending the use of explosive mixtures containing chlorates.

A New Candle.—A French chemist makes a new kind of candle by dissolving 5 parts of colorless gelatine in 20 parts of water, adding 25 parts of glycerine and heating until a perfectly clear solution has been formed. To this is added 2 parts of tannin dissolved by heating in 10 parts of glycerine. A turbidity is produced which should vanish on further boiling. The boiling is continued until the water has been driven off. The mass is then cast into ordinary glass candle moulds. The candles obtained in this way are as clear as water and burn quietly, and without spreading any odor.—American Druggist.

Preparation for Use After Shaving.—Try one of the following:

1. Bay rum	8	pt.
Glycerine	½	"
Extract violet	½	oz.
Rose water	½	pt.

Mix and filter if necessary.

2. Glycerine	6	fl. oz.
Quince seed	½	dr.
Alcohol	5	fl. oz.
Oil rose	16	mins.
Hot water	21	fl. oz.

Pour eight fluid ounces of the water upon the quince seed, agitate well until a mucilage is formed, and strain through muslin. Pour the remainder of the hot water into a bottle, add the oil of rose, and shake well. Finally add the alcohol. If desired, the preparation may be tinted by the use of a little aniline.—Pharmaceutical Era.

Coltsfoot Rock Candy.—

Purified extract of licorice	1 lb.
Water	q. s.
Tragacanth	2 oz.
Sugar	28 lb.
Spirit of lemon	1 fl. oz.
Extract of poppies	2 fl. oz.
Spanish brown	q. s.

Dissolve the licorice in twelve fluid ounces of water and swell the tragacanth in twenty fluid ounces of water. Mix these and add the other ingredients, using a sufficient quantity of Spanish brown to color the candy. Make into a paste. By means of a piston and screw, force through a metal tube having star shaped holes at the bottom. Cut into lengths and dry.—Meyer Brothers' Druggist.

Pyroligneous Acid for Smoking Meat.—Take the meat out of the pickle and dry; with a sponge or brush, wash all over with crude pyroligneous acid; hang up in a cool place, and repeat the application at intervals of a few days, until three coats have been applied.

Eucalyptus Tooth Paste.—

Precipitated chalk	160	parts.
Powdered soap	45	"
Wheat starch	45	"
Carmine	1	"
Oil of peppermint	2	"
Oil of geranium	2	"
Oil of eucalyptus	4	"
Oil of clove	1	"
Oil of anise	1	"

Mix, and mass with equal parts of glycerine and alcohol.—Pharm. Post.

ENGINEERING NOTES.

During the months of March, April, May and June, 1896, the four vestibuled limited trains of the Chesapeake & Ohio Railway between Washington and Cincinnati made a remarkable record. Each train covered 509 miles 122 times, a grand total of 292,312 miles, or nearly 11¾ times the earth's circumference, and yet the four trains were on time 463 times out of a possible 488, an average of 95 per cent.

The Ferracute Machine Company, of Bridgeton, N. J., has received an order from the Chinese government, through the regular authorized agents, for an outfit of mint machinery for making the Chinese coins of copper known as "cash," says the Western Electrician. The machinery consists of five coining presses with attachments and dies, similar to those furnished to the United States mint in Philadelphia, and two punching presses with feed attachments and dies for cutting the blanks; also, several extra dies and some other special machinery, the whole order amounting to about $13,000.

Her Majesty's Secretary of State for Foreign Affairs has received a dispatch from Her Majesty's agent and consul general at Sofia stating that tenders are invited by the Bulgarian Ministry of Public Works before October 19 next for the Rustchuk-Nova Zagora Railway, and before November 5 for the Saramby-Nova Zagora Railway. It appears that the respective "cahiers de charges" are open to inspection at the ministry in question, and that copies may be bought there for 20f. each. Such particulars as Her Majesty's government has received on the subject may be viewed at the commercial department of the Foreign Office between the hours of 11 A. M. and 6 P. M. daily.

Two steel oil tank vessels, built at West Superior for the Standard Oil Company two years ago for lake service, are on their way to the Atlantic, where they are likely to be used in the coastwise trade, says the Engineering and Mining Journal. They were built as experiments and now their places in lake service will be taken by two of the largest size, with a capacity of 750,000 gallons of oil each. The intention of the Standard Oil Company is to do away with rail transportation of oil from its Indiana works to the Northwest, as far as possible, by sending the oil in barges from Whiting to the head of Lake Superior, where it will be pumped into tanks and barreled for shipment to the company's distributing stations. The capacity of the tanks at Superior, Wis., has been increased.

Miners are becoming interested in a new mining explosive described by Prof. F. Kleinpeter, of Vienna, which is being introduced in Austria. The name given to it is Dahrnenite A, and its strength is said to be 33 per cent. greater than the best gelatine dynamite, and, in consequence of the large volume of gas which it produces—being approximately double that yielded by dynamite—it has a wedging rather than a pulverizing action, resulting in a materially increased fall of lump coal. Other advantages mentioned are that it can be compressed without losing any of its explosive force, and in this state it is claimed even to exceed dynamite. A weaker detonator is required to bring it to explosion than is demanded for any other known safety explosive, and it is better able to withstand the effects of storage, and no decomposition can take place when the packing is proper. Indeed, such is the safety with which it may be handled that the German railways allow it to be carried on any train.

A committee of the American Master Mechanics' Association has been making experiments on exhaust nozzles, and has arrived at the following conclusions: (1) The action of the exhaust jet within the stack is not that of a piston within the barrel of a pump. (2) Draught can as well be produced by a steady flow of steam as by the intermittent exhaust jet. (3) The exhaust jet, under ordinary conditions, does not fill the stack until near its top. (4) The vacuum within the stack, at points near its base, is greater than that within the smoke box. (5) The jet acts upon the smoke box gases in two ways; first, by frictional contact it induces motion in them; and secondly, it enfolds and entrains them. (6) In all jets examined, the induced action was relatively strong and the entraining action weak. (7) Any condition which will tend to solidify or to reduce the spread of the jet appears to affect favorably its efficiency. (8) Changes in stack proportions may greatly affect the form of the jet. (9) In general, a change in the amount of steam discharged will change the form of the jet, the spread being reduced as the volume of steam is increased. (10) Other conditions being the same, the form of the jet is not much affected by changes in speed or of cutoff. (11) The form of the nozzle has much to do with the form of the jet, and hence with its efficiency.

Some successful trials have been made by Sulzer Brothers, St. Petersburg, with a specially constructed triple expansion engine. Engineering describes this engine as of the horizontal two crank type, having four cylinders, the high and one of the low pressure cylinders being placed tandem behind one crank, while the intermediate and second low pressure cylinders have similar arrangement behind the other. The high pressure cylinder is 2·49 feet in diameter, the intermediate 3·70 the low pressure cylinders each 4·29, and the stroke in all cases 6·56 feet; the valve gear is of the Sulzer type, four poppet valves to each cylinder; the covers jacketed as well as the body of the cylinders and the steam supply passes through the jackets on its way to the admission valves; a condenser and a horizontal direct acting air pump are arranged behind each pair of cylinders; the flywheel is grooved for thirty-six two inch ropes. Steam is supplied from eleven Cornish boilers, having a total of 5,272 square feet of heating surface; and above each boiler are fitted two vertical steam drums, kept hot by the waste gases from the furnaces, which dry, though they do not superheat, the steam. In the trials made, the engine is said to have developed from 1,897 to 1,848 indicated horse power at about fifty-six revolutions a minute, the consumption of fuel ranging from 11·1 pounds to 11·2 pounds per horse power per hour, jacket water being included; the coal burned per indicated horse power per hour ranged from 1·1 pounds as a minimum to 1·3 pounds as a maximum.

ELECTRICAL NOTES.

It is said that surgical instruments are now made of wood, which is afterward completely covered with a layer of nickel, electrically deposited.

A shepherd's body was recently carbonized by electricity at Roche la Mollière in France. During a thunder storm the telegraph wires were blown down and curled around the man, who was standing under them.

Some experiments on the electric transmission of power made at the works of the Central Stamping Company, Brooklyn, showed that in an average day's work the engines using belt transmission indicated 44·1 horse power, while with the electric system the same work was accomplished with but 25·7 horse power. In France, also, the system of electric transmission appears to be in favor, the famous steel works of Firminy employing the method largely for tool driving.

An experiment in pumping oil wells by electricity was made recently on the property of Mr. J. Menisinger, at Lima, O., says the Electrical Engineer. The current was taken from the street railway circuit at 500 volts and a Triumph 5 horse power motor was used. The outfit worked well and gave much ground for encouragement, but the uneven supply of current made the operation of the plant unreliable. What is needed is a special plant or a regular power service.

The question of electric traction is being seriously considered in Berlin, where negotiations are in progress between the company and the municipal authorities. The suggested conditions comprise an extension of the concession to 1919. The overhead system will be adopted, save in certain streets where the municipal authorities may require the use of accumulator cars. As these cars pass into the outlying districts they will work on the overhead system, during which time their accumulators will be recharged.

The following is a rough rule for estimating the fall of potential on an electric wire circuit: For a drop of 10 volts the ampere feet are equal to the section of the wire in circular mils. Thus, suppose 300 lamps taking ½ ampere each are to be supplied at a distance of 500 feet, allowing a drop of 10 volts. Then the total length of wire is 1,000 feet and the total amperes 150. Hence ampere feet = 150,000 = circular mils of wire section, and hence diameter of wire = $\sqrt{150{,}000}$, i. e., 387 mils.

A new and cheap process for the manufacture of the incandescent mantles employed in the Welsbach burner has been patented in Germany. It consists in mixing with the nitrates or sulphates of the earthy metals used the salts of their bases, thus forming an electrolyte, through which a current is passed into a skeleton of fine woven platinum wire, shaped like a mantle. On this framework the metals are electrolytically deposited and subsequently calcined, after which the platinum skeletons are removed. Mantles made in this manner are claimed to be stronger than mantles made in the ordinary way, and, further, the cost of manufacture, according to present methods, is considerably reduced.

M. L. Benoist has devised a three-leaved electroscope, which he states is considerably more sensitive than the ordinary two-leaved form, says the English Electrical Review. The general arrangement is precisely the same as in the ordinary electroscope, except that there are three leaves instead of two. The cause of the increased sensibility is obvious, for the repelling surfaces are not the two diverging leaves, but each of the latter and the central one, so that the distance between the repelling surfaces for a given divergence is half what it is in the ordinary electroscope. For small angular divergences the sensibility becomes increased in the proportion of 1 to 1·49 over the two-leaved instrument. In the two-leaved instrument, moreover, the maximum divergence is 90°, but in the three-leaved form it is 120°.

The political parade at Indianapolis on October 15 was witnessed by 75,000 people packed along the line of march. There were bands and transparencies galore. The post of honor was given to a locomotive of unusual size which was propelled by trolley power along the street car tracks. It had enough steam, however, to whistle, and the stack emitted smoke. Its name was "Sound Money," and an engineer and fireman peered out of the windows upon the multitude. Its headlight was electric and it had an electric keystone in front. Following an old-fashioned street car drawn by mules and labeled "Before Crime of '73," was a handsome electric train filled with shouting people and bearing in electric letters "After Crime of '73." The wind-up of the parade was a caboose surmounted by an electric search light. The parade surpassed anything ever seen in Indianapolis in novelty and enthusiasm.

At present there is in London only one electric underground road, but this has been such a conspicuous success in the minds of English capitalists that six new systems have been authorized, two of which have been constructed, says the Boston Journal of Commerce. These railways will be tunneled on the "Greathead shield system," at an average depth of sixty feet beneath the pavement of London, and no sign of their progress will be visible to those who use the streets, excepting on the sites of the proposed stations, where shops and houses are being demolished. The public attention just now, says the Electrical Engineer, is directed principally to the Central London Railway, which will run from Shepard's Bush to Liverpool Street, a distance of 6¼ miles. There will be fourteen stations along the route, the trains stopping at each station and running at intervals of 2½ minutes. The cost of construction and equipment, which is calculated at $2,500,000 per mile, aggregates a total of $17,-500,000. At some points on this line the rail level will not be less than eighty-five feet beneath the surface, and hydraulic lifts will convey passengers to and from the trains. Subways will be constructed for foot passengers to cross from one side of the road to the other. The company expects to carry between 50,000,000 and 60,000,000 passengers in the year. The boring of the two tunnels, which will be circular and lined with iron, and 11 feet 6 inches in diameter, will be proceeded with from each station simultaneously, so that the work will be completed, it is expected, by December, 1897.

MISCELLANEOUS NOTES.

Parisian lovers of horseflesh devoured more than 30,000 horses last year. In 1894 the number was 21,227, in 1878 it was 10,000, and in 1872, 5,034. There are 200 hippophagous butchers in Paris.

It appears that a new and very objectionable manner of advertising has been devised in Great Britain. In the bedrooms of some of the leading hotels, not only toilet articles, but also patent medicines are placed, in the hope that guests will use and pay for these.

Japan's Diet voted $45,000,000 for the construction of railroads, telegraphs, and cables at its last session, and $97,000,000 for the construction and purchase of war materials and ships. Since January, 1895, $600,000,000 has been invested by Japanese in banks, railroads and other companies.

The Northwestern Lumberman says: "In Harbor Springs, Mich., there is a large and flourishing wood toothpick industry. White birch is exclusively used in the manufacture of the toothpicks, and about 7,500,000 are turned out daily. The logs are sawed up into bolts each 28 inches in length, then thoroughly steamed and cut up into veneers. The veneer is cut into long ribbons three inches in width, and these ribbons, eight or ten at a time, are run through the toothpick machinery, coming out at the other end, the perfect pieces falling into one basket, the broken pieces and refuse falling into another."

One hears a great deal at all the lake ports of the approaching end of the white pine trade, for it is said that at the present rate of consumption it will only be twelve or fifteen years before the forest lands will be stripped. The last legislature created a new office—that of forest warden—whose duty is to investigate and report upon the condition of the timber of the State and recommend legislation for its restoration. His first report, which has just been issued, shows that there remains in Minnesota 10,890,000 acres of forest land, covered with 19,000,000,000 feet of white and Norway pine. The annual destruction amounts to 1,800,000,000 feet.

Magazines for the blind, printed in a raised type called Braille, are published by the British and Foreign Blind Association, 33 Cambridge Square, Hyde Park, W. Recreation, a magazine for blind adults, is published on the fifteenth of every month, its year beginning in January. The subscription is $2.25 a year, postage free for the United Kingdom, $2.50 for abroad. Playtime, a magazine for blind children, is published on the first of every month, its year beginning in June. The subscription to Playtime is the same as that of Recreation. The subscriptions cover the cost of the printing and paper, the metal plates being given. The publishers make no profit on the magazines.

Russian peasants are emigrating to Siberia in numbers that alarm the government. The part of the Siberian railroad opened has been blocked by the rush, 13,000 persons being encamped at Techlyabursk in the middle of May waiting for transportation. So far this year 145,000 have emigrated, whole villages being left without inhabitants, to the great embarrassment of the elder, who is responsible for the payment of taxes and finds only deserted farms on which to levy. Plentiful, cheap land is the attraction to Siberia. It is reported that the government will stop banishing criminals to Siberia, and will use only the island of Saghalien, the northern provinces, and the prison districts as receptacles for convicts.

Sewing machines are found in Turkey not only in the seaports and the districts served by the railways, but also in Erzeroum, Diarbakir, Damascus, etc. Their introduction is principally due, according to the Handels Museum, to a German-American house, which has established about 150 agents in Turkey. At the present day Turkish, Greek and Armenian women appear to appreciate very highly the usefulness of the sewing machine and its advantages over manual labor. Of the 18,000 to 20,000 machines imported annually into the Ottoman Empire, the greater part are for the use of families and consist of hand machines, while the remainder is composed of treadle machines for use in the various industrial establishments. These machines come not only from Germany, but also from England, the United States and Austria.

In a recent number of the Papier Zeitung, a method of manufacture of briquettes from small coal and concentrated waste sulphite liquors was described. The experiments were conducted at the iron smelting furnaces at Kemit at Comor, in Hungary. The waste sulphite liquors were obtained from a pulp mill in the vicinity, and then concentrated to a suitable consistency in a series of open tanks heated by the waste gases from the furnaces. The thick sirup-like residue was mixed with the coal dust in the briquette making machine. The briquettes, when dried, were hard, and formed an excellent fuel, giving off practically no sulphurous odor when burnt. It was also found that by using sufficient lime flux, practically the whole of the sulphur went into the slag when employed in the smelting furnace. It is stated that these briquettes not only form good fuel upon ordinary grates, but also in the smelting furnace.

There are said to be Michigan white cedar shingles now doing good service on roofs in that State that have been in full exposure and wear for over seventy-five years. It is thus seen that climate affects the durability of shingles, and the fact that white cedar is the natural product of Michigan and red cedar of the Pacific coast is held to be proof that the red cedar is naturally adapted for use on the Pacific coast and the white for use in such sections as the middle and Northwestern States, etc. A peculiar objection is brought against the red cedar by some, namely, that there exists in that wood an acid which is, in the climate of certain sections, so acted upon by water as to corrode rapidly the nails with which the shingles are fastened on to roofs, the rust extending to the wood around the nails, and soon causing a leaky roof—this action explaining the holes so often to be seen around the nails in red cedar roofs. Another point offered for consideration in this connection is the fact, as stated, that a shingle is ruined by kiln drying, and that no kiln-dried lumber can be regarded as of equal value for outside work to that which is air-dried.

THE HISTORY OF THE GREAT LAKES AND NIAGARA.

By ANDREW J. HERBERTSON, in Knowledge.

THE problem of the origin of the great lakes and Niagara has always been an interesting one, and various theories have been put forward to explain it. Dr. J. W. Spencer, of the Geological Survey of the Great Lakes, has recently published a set of papers in which he attempts to reconstruct the past history of the great lake region of America.*

Dr. Spencer believes that between the middle Miocene and early Pleistocene periods the region stood three thousand, perhaps even five thousand or six thousand feet higher than at present. In support of this he appeals to the evidence of soundings round the American coasts which reveal the existence of what appear to be ancient river channels. For instance, were the water to sink six hundred feet below its present level the banks to the south of Newfoundland and Nova Scotia would be dry land; but this would be traversed by a deep fjord over three thousand feet deep where it joined the sea, whose depth near its mouth would be five thousand feet. This channel, sixty miles wide at its mouth, follows for over eight hundred miles the bed of the present St. Lawrence River, growing narrower and shallower as it projects inland. Dr. Spencer supposes that previous to the existence of the present lake basins the continent was much higher and was drained by a great river, which he names the Laurentian River, which excavated this deep chanel. The depths of the various lakes afford corroborative evidence, the floors of Ontario and Superior being almost five hundred feet below the present sea level, that of Michigan three hundred feet and of Huron one hundred and fifty feet. The soundings of the lakes and borings in various regions reveal the ancient beds of this Laurentian River and its tributaries. Lake Michigan was drained by two rivers, one in the northern basin which flowed by the present outlet to Lake Huron, in the middle of which it was joined by a tributary running from the southern basin of Lake Michigan, across the present State of Michigan, and through Saginaw Bay. The united streams did not flow southward toward Lake Erie, but first northwestward to the present Georgian Bay, then southeastward near its western shore, and by Lake Simcoe, turning to the eastward at a point in Lake Ontario nearer the southern than the northern shore, and thence to the sea by the present course. The Lake Erie basin was drained by another tributary which turned northward by the Grand River and Dundas Valleys, and curved eastward again at the western end of Lake Ontario, joining the Laurentian main stream at its bend opposite the mouth of the present Niagara River.

This river and its tributaries had eroded the region and formed broad valleys just before the Pleistocene period, and during that period, and particularly toward its end, parts of the old valley were gradually blocked. This blocking of the valley may have been due to the accumulation of glacial drift at some places, but Dr. Spencer believes that terrestrial warpings are a more important factor, and that these to a certain extent are measurable. The absence of glacial markings in the direction of the axis of the lakes goes to prove that they have not been hollowed out by ice.

Round the great lakes are found traces of terraces composed of waterworn pebbles, the result of the action of waves or of currents. These Dr. Spencer has examined and surveyed, and concludes that they are of marine origin at a time when there was a depression of the surface to over two thousand feet below its present level. He does not discuss the theory that they may have formed the shores of lakes retained by moraines, but he points out that glacial lakes retained by ice are neither large enough nor sufficiently long lived to account for such beaches. The depression of the continent at the time of the newest till is no more impossible than the generally admitted elevation of the pre-Pleistocene period, but the discontinuity of the terraces and the absence of salt water deposits are difficulties in the way of the theory of their marine origin. The first of these objections is met by the answer that these terraces have not yet been perfectly explored, that subsequent terrestrial movements may have deformed them, and that erosive and other agents have been at work modifying the topographical features. As to marine deposits, these are found at a height of five hundred and twenty feet, but their absence at higher levels is not evidence of the non-marine character of these old shores, since there are many marine beaches in which no fossils are found.

When the depression of the land was greatest, the region of the great lakes was then a huge ocean gulf whose shores formed one of the raised beaches Dr. Spencer has surveyed. It is possible that at times the narrower parts of the gulf may have been filled up from giant glaciers, but these ice barriers could not retain a vast volume of water for any lengthened time.

But a close examination of the raised beaches leads to other conclusions. They do not lie parallel to the present water surface of the great lakes, but are usually higher above the lake level in the east than in the west, in the north than in the south. This affords important evidence of terrestrial deformation having taken place since the formation of these beaches; and these alterations of levels have resulted in the formation of the great lakes.

The first uplift seems to have taken place in the region to the southeast of the present Lake Huron, and when the land had risen one hundred and fifty feet the upper waters of the original gulf, covering Lakes Superior, Michigan, Huron, and Georgia, were separated from the lower waters which extended over the present Lakes Ontario and Erie. This great lake was at first joined to the sea by a broad strait covering the present Lake Nipissing and the Ottawa Valley.

The next event was the isolation of Lake Erie, and at first its waters, too, flowed to the Ontario Gulf without any perceptible fall. The upward movement of the land continued until there were three hundred feet of difference between the levels of the gulf and the lake, and the Niagara Falls came into existence. But the water falling over them was only that of Lake Erie, for the overflow of the upper lake still took place by the Ottawa Valley. This was the time when the beach round Lake Ontario (which Dr. Spencer calls the Iroquois) was formed approximately at the sea level, and must have been after the uppermost drift was deposited, as it rests on mud covering the till. This beach is three hundred and sixty-three feet above the sea (one hundred and sixteen above the lake) at the western end of the lake, but it rises especially in the north, and at the east end it is six hundred feet higher than at the west end.

As the uplift continued more rapidly in the east than in the west the communication with the sea was gradually closed, save by the present channel of the St. Lawrence, and Lake Ontario was formed. The rising of the land went on, with some short pauses, until the level of the waters ultimately reached eighty feet below the present surface at the mouth of the Niagara Gorge, when the Niagara River was about four miles longer than now.

The Niagara River, which had first been a strait joining Lake Erie to the Ontarian Gulf, became a wide, shallow, rapid stream; and then, as the waters of the lower lake subsided, its bed narrowed and its fall increased to four hundred and twenty feet. But the river was soon greatly enlarged. The land was rising to the north of Ontario as well, and ultimately the outlet from Lake Huron to the Ottawa Valley was blocked, and the surplus water of the three greatest lakes flowed by their present course to Lake Erie, and thence by the Niagara River.

With the continued rise of the land, especially toward the east of Ontario, the water level rose until it attained its present elevation, and the fall of the river between the two lakes was reduced to the present three hundred and twenty-six feet.

Can dates be assigned to these events? The first estimate of the age of Niagara River was given by Ellicott over a century ago at fifty-five thousand four hundred and forty years; Bakewell, in 1830, gave twelve thousand; Lyell's estimate of thirty-five thousand was accepted for many years after 1841; but recent writers, using the mean rate of recession during forty-eight years as determined by surveys, make the value about nine thousand years.

Dr. Spencer has made a new and careful computation of the age of the Niagara River and Falls. He shows that the recent estimates have not taken into account the various changes that have occurred in the fall and volume of the river. His calculations result in a value nearly that of Lyell's. Dr. Spencer believes the Niagara River was formed thirty-two thousand years ago, and that a thousand years later the falls were in existence. For seventeen thousand two hundred years their height was about two hundred feet; thereafter the water fell four hundred and twenty feet. Seven thousand eight hundred years ago the drainage of Lakes Superior, Michigan, and Huron first flowed through the Niagara Gorge, and three thousand years ago the waters rose in Lake Ontario until the level reached that of to-day. The falls, then, are thirty-one thousand years old. This estimate, calculated from the rate of erosion, is confirmed by another made from the terrestrial movements.

Two deductions may be given—one as to the past, the other concerning the future.

The lakes came into existence after the glacial epoch, and Niagara after the lakes; and calculations based on the mean rate of rise of the beaches in the earlier period of the lakes' history show that "the close of the ice age may safely be placed at fifty thousand years ago."

As to the future. "With the present rate of calculated terrestrial uplift in the Niagara district, and the rate of recession of the falls continued or even doubled, before the cataract shall have reached the Devonian escarpment at Buffalo, that limestone barrier will have been raised so high as to turn the waters of the upper lakes into the Mississippi drainage by way of Chicago. An elevation of sixty feet at the outlet of Lake Erie would bring the rocky floor of the channel as high as the Chicago divide, and an elevation of seventy feet would completely divert the drainage. This would require five thousand to six thousand years at the estimated rate of terrestrial elevation."

* "The Duration of Niagara Falls and the History of the Great Lakes." By J. W. Spencer, A.M., Ph.D., F.G.S. Second edition, 1895. (Albany: The Commissioners of the New York State Reservation at Niagara.)

SCHOOL GARDENS IN RUSSIA.

A VERY interesting feature of primary education in Russia, says Nature, is the establishment and rapid development of small farms, orchards, and kitchen gardens in connection with many primary schools, especially in the villages. The land for such model gardens, or farms on a small scale, was mostly obtained through free grants from the village communes, and, occasionally, from the neighboring landlords; while the expenses are covered by very small money grants from the country and district councils (zemstvos). To take one province in South Russia, namely, Ekaterinoslav, we see from the biennial report, just issued, that not only has almost every school an orchard and kitchen garden for the use of the schoolmaster, but that nearly one-half of the schools in the province (227 out of 504) are already in possession of small model kitchen gardens, orchards, tree plantations, or farms, at which gardening, sylviculture, and sericulture are regularly taught. The teaching is mostly given by the schoolmasters, who themselves receive instruction in these branches at courses voluntarily attended in the summer, or occasionally by some practical specialist of the neighborhood. The province of Ekaterinoslav being mostly treeless, special attention is given to tree plantations and next to silkworm culture. The aggregate area of the 227 school farms or gardens attains 283 acres, and they contained, in 1895, 111,000 fruit trees and 238,300 planted forest trees, nearly 14,000 of the former and 42,000 of the latter having been distributed free among the pupils during the same year. The money grants for these 227 gardens were very small—i. e., a little over three hundred pounds (£314). Besides, over a thousand beehives are kept, partly by the schoolmasters and partly by the children; and some schools had vineyards in connection with them. This movement has widely spread over different provinces of Central Russia, where the culture of cereals dominates at the school farms; while in Caucasia attention is especially given to the silkworm culture and the culture of the vine.

THE seventy-fifth birthday of Rudolph Virchow was celebrated in Berlin, on October 13, with fitting ceremonies.

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